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Forthcoming Events.

DECEMBER 10.

Institute of Metals (Scottish Local Section):—Ordinary meeting at Glasgow. "Scottish Moulding Sands and their Application to Non-ferrous Casting," Paper by E. Hudeon.

DECEMBER 11.

Sheffield Metallurgical Association:—Ordinary meeting at Sheffield. "Works Tests of Refractories and Service Results," Paper by R. J. Sarjant, M.Sc.

DECEMBER 13.

Institute of Metals (London Local Section):—Joint meeting with the Institute of British Foundrymen at 83, Pall Mall, S.W.1. "Aluminium-Silicon Alloys—their Properties and some Applications," Paper by R. B. Deeley, B.Sc., A.R.S.M.

Institute of Metals (Birmingham Local Section):—Ordinary meeting at Birmingham. "Magnesium Alloys for Engineering," Paper by E. Player.

DECEMBER 14.

Institute of Metals (Sheffield Local Section):—Ordinary meeting at Sheffield. "Chromium Plating," Paper by L. Wright, B.Sc.

West of Scotland Iron and Steel Institute:—Ordinary meeting at Glasgow. Paper to be read by Professor W. R. Scott, M.A.

Institute of British Foundrymen.

DECEMBER 11.

Lancashire Branch (Burnley Section):—Ordinary meeting at Burnley. "Comparison of English and French Moulding," Paper by J. Stanworth, M.B.E.

DECEMBER 13.

Scottish Branch (Junior Section):—Ordinary meeting at Glasgow. "The Cupola," Paper by Angus C. Miller.

DECEMBER 14.

Lancashire Branch (Burnley Section):—Ordinary meeting at Burnley. "Comparison of English and French Moulding," Paper by S. Stanworth.

Middlesbrough Branch:—Open discussion on foundry problems. "A Novel Method of Cupola Charging," Paper by R. J. H. Ritchie, and "Pattern Making," Paper by Dan Taylor.

DECEMBER 15.

Lancashire Branch (Junior Section):—Ordinary meeting at Manchester. "The Application of the Microscope to the Study of Metals and Alloys," Paper by G. Mohn, M.Sc.

Newcastle and District Branch:—Ordinary meeting at Neville Hall. "The Production of Malleable Castings," Paper by F. H. Hurren.

Scottish Branch (Falkirk Section):—Ordinary meeting at Falkirk. "The 'Safety First' Movement in Foundries."

Wales and Monmouth Branch:—Ordinary meeting at Cardiff. "Refractory Materials," Paper by W. R. D. Jones.

The Census of Production.

The future of this country is very largely bound up with its industrial output, and yet it is remarkable that only on three occasions has an attempt been made to assess it. The first census was held in 1907, and the results of the second in 1912 were not issued owing to the war, and this census was, in any case, incomplete. The third and last census was taken in 1924, and the results were issued late last year.

Some of the figures are of the greatest interest, as they illustrate industrial tendencies. For example, the relative proportion of men and women gainfully employed were very much the same in 1907 as they were in 1924, but there has been a decrease of youths under 18 and an increase of girls under 18. The administrative, technical and clerical staffs engaged in industry increased from 8 per cent. of all those engaged in industry in 1907 to 11.5 per cent. in 1924, a change which emphasises the tendency to modern methods of management. The number employed in the iron and steel trades declined; in the engineering group increased. Shipbuilding also increased slightly, but motor and cycle manufacture increased its number four times.

The increase in output is somewhat difficult to gauge, and the figure is given with some reserve. It is said that there was an increase in finished goods in 1924 of 19 per cent. compared with 1907, while the increase in labour was 13 per cent. This suggests a slight net increase in output, but the figure is disappointing when one bears in mind the enormous advance made in electrification, labour-saving machinery, the shorter working day, and so on. The horse-power available in 1907 was 8.8 millions, and in 1924 it was 11 millions, plus another 4.5 millions for electric motors driven by purchased electricity. Mechanical power per head of the working population has increased between 1907 and 1924 not less than 7½ per cent., and possibly as much as 40 per cent., according to the return.

When this increase is considered, the increased output per head is very small, and may well be compared with the figures quoted by Mr. C. G. Renold, referred to in a recent issue.

The best view to take of the situation is that during a time of comparative industrial depression the whole of the power was not in use, and that during a period of intense adaptation to new markets, output is not likely to be so great as under normal conditions.

Taking the figures for the iron and steel group, for founding is not statistically separate, but accompanies blast furnaces, smelting and rolling, there were 265,400 employed in 1907, against 250,300 in 1924. Thus there has been a fall, but the headway made by the electrical, engineering and motor trades has resulted in an increase of 22 per cent. The heavy section employs about one-half the technical, administrative and clerical staff employed by the engineering group. The effect of irregular output and short time in the engineering group is shown by the fact that in 1907 the net output per head of the iron and steel group was 8.6 per cent. above the average for the country. In 1924 it was 8.5 per cent. below the average.

What are Light Castings?

There has recently been an extensive discussion in the foundry industry as to what exactly comes under the general classification of "light castings." One section insists that it merely designates those castings consumed by builders and bought through builders' merchants. This would necessarily include a type often designated as municipal castings—gulley grates and manhole covers. Another school of thought insists that light castings are those created from the use of high phosphoric iron—undoubtedly this has much to commend it. Other founders would extend the classification to include all castings which reach the consumer without being machined, beyond the drilling of a few holes. This definition rather appeals to us, but obviously there must exist numbers of castings made for marine, electrical, textile, and railway engineering which would be embraced.

"Light" is such a comparative term that we would suggest in all seriousness its complete elimination from trade nomenclature, and no attempt should be made to find an alternative term. Founders making what has hitherto been described as light iron castings could easily describe themselves as, say, manufacturers of "builders' and electrical castings," or again, "municipal and light textile castings." The indefinite nature of the word "light" as an adjective qualifying castings is far too vague to warrant its commercial continuation.

XUM

A Consideration of the Various Claims for Producing High-class Cast Iron.*

By Horace J. Young.

The subject presents initial difficulty in that many makers and users appear to possess small idea of, and smaller facilities for ascertaining, what is—as distinct from what is not—cast iron which is worth more than ordinary iron. Therefore, the author opens his Paper with a definition.

He thinks that *cast iron—of any one type whatsoever—is high-class iron when it appears in the castings made of it as a standard metal, never varying from casting to casting and possessing qualities—structure, composition and physical properties—particularly suitable, firstly, to the moulds used and, lastly, to withstand the service conditions of the casting or castings concerned.*

The subject is allied to that one of waster castings because where cast iron must be genuinely high-class, as defined above, it becomes imperative to scrap a good casting when its metal is not true to type, whilst still having to scrap castings by reason of poor workmanship or foundry mishaps.

Fear of waster castings has been a factor in preventing metallurgical progress and innovation. Some foundries are receiving to-day advice which consists of little else than ordinary mixtures and cupola-practice camouflaged under a scientific garment. This may well explain why some so-called "special" cast irons are rarely twice alike. It may throw light also upon the fact that some firms purchase, from outside foundries, their high-class castings to the detriment of their own balance sheets, of their own foundries (if they have them) and also of their own engines in cases where the "special" iron is either unsuitable to their purpose or varying in quality.

Specifications Inadequate.

The real preventive of progress, however, lies in the rut into which founders have slipped, and remain fixed so firmly in all that concerns the specification and testing of cast iron. Looking back over years of practice, the author can recall no specification which proved, or in any way attempted to prove, that the iron in the castings was of any particular quality. One works using one iron could pass a specification, whilst another works using a totally different iron, also passed it. It is obvious that hundreds of different kinds of iron will give a tensile of, say, 11 or 15 tons per sq. in. To specify iron in that manner is similar to selecting a motor car on the one proviso that it will go 30 miles an hour. Further, to specify iron on shaped test bars attached by stilts to the casting or upon separately-cast bars is similar to choosing a motor car on the stipulation that some other car altogether will go 30 miles an hour.

This matter of specification is of overwhelming importance to modern engineering. It is impossible to exaggerate the gravity of the present state of affairs. For instance, a heavy superheated-steam cylinder-liner to give satisfaction in service must, necessarily, be composed of metal possessing certain qualities. If the iron of the shaped test bar, attached by stilts to the casting, be grey one is aware for a certainty that the metal in the liner is unsuitable. If, however, the test bar be white or mottled or not run properly, one is assured that the iron in the liner may be good. Hence, the ordinary specification completely defeats its own object, because to pass the specification one must make a metal suitable to the test bar and unsuitable to the liner.

Again, take the case of a turbine casting weighing, say, 10 to 20 tons, and where the specification says that the shaped and attached test bar or the separately cast test bar, shall give 9 or 12 tons tensile. The metal of which one such casting was composed appeared to the author to be so poor that he condemned the casting. Test bars cut out of it broke at 6 to 7 tons per sq. in., and the iron was hopelessly inferior in all ways. The specified test bars had satisfied the specification, and by so doing had defeated the object in view, and had proved falsely that a bad metal was a good one.

Another example—and an important one in these days—is where heat- or wear- or impact-resisting metal is wanted. The ordinary specification provides no means of proving any of these properties of the metal in the castings, and will defeat its own object by allowing all manner of undesirable irons to pass its provisions. In these times it would seem unnecessary to mention that old-fashioned slogan, "close-grained iron." Yet not a few engineers still specify it. Within the past two years the author has been in four large works where it was the sole specification for their most expensive and important castings. In each works, the author was able to point out that the freshly machined castings required merely a glance to show that they were not close-grained, and that, therefore, the only property specified was being attended to by neither the suppliers nor the purchasers. The day that engineers specify cast iron in a metallurgical manner will be a happy one for foundries which are trying genuinely to do better.

Test Bars Unrepresentative.

At this point the author desires to draw attention to a statement made recently regarding a new specification. It says:—"*The problem of securing a test bar which would accurately represent the mechanical properties of the metal in the castings has been one of the difficult problems the industry has had to face, and this has involved a large amount of experimental work, etc.*"

To the unitiated the above is liable to be misleading because the specification in question is not supposed to provide testbars accurately representing the metal in the castings. For instance, under its conditions a testbar of 2.2 in. dia. can be cast separately from or attached by stilts to a casting of any weight, be it 20 lbs. or 20 tons, so long as its main cross-sectional thickness is 2 in. or over. Hence a separately-cast bar can be used to represent a 9-ton propeller, a 15-ton bridge column, a 2-cwt. plate, a 3-ton cylinder liner, a 12-ton cylinder, and so on. The specification referred to is a valuable effort on the part of a large number of people to provide something to suit everyone making or using castings of general and ordinary quality, but anyone of experience could produce a hundred different castings to-morrow where testbars of this kind would not represent the mechanical properties of the iron in the castings themselves. The author draws attention to this because the specification position is so bad that it will be highly detrimental to the industry if new misconception is introduced.

High-class cast iron can be specified by ultimate composition plus certain physical and structural tests made on bars cut out of the castings. There is no difficulty about it and tolerances can be arranged to which any genuinely-controlled foundry will work. The author has worked on these lines for many years, and such success as he has had he attributes to that procedure.

During the past two years the author has acted for a firm which, purchasing its castings from various foundries, manufactures them into an article of engineering use. Their composition—carbon, silicon, phosphorus, sulphur and manganese—is specified together with certain physical properties. A piece out of each casting is tested and analysed. The result is that the purchasers receive standard irons and the ones they desire and pay for; they know how their products are behaving in service and which behave best under certain conditions. Moreover, every engineer buying these manufactures is getting a standard article—a very different position from that one where the quality is unknown or seldom twice alike.

Roll Founders' Knowledge.

An easy casting may become a difficult one when the metal needs to be correct in the casting itself. That is one reason why those continually engaged in chill-roll and such like industries know things about cast iron which ordinary foundry people do not.

Almost any castings which needs (1) to be free from blemish when machined all over, or (2) to be of a desired composition, or (3) to possess a certain hardness, or (4) to have a certain structure in working parts, or (5) to consist of heat- or wear- or impact-resisting iron, becomes a difficult casting to make even though comparatively easy under ordinary conditions.

Coming to the consideration of the claims made for producing high-class irons, it is the author's experience that some claims are unjustified by results whilst a few are deliberately fictitious. For example, he was asked to reproduce a casting described and advertised as being composed of special heat-resisting cast iron. It contained 2.0 per cent. of silicon and was an ordinary free-running foundry iron with no pretensions whatsoever to heat-resisting properties. The price offered did not warrant anything better, and, being a light casting it would have meant spending a little money before it could have been made successfully in heat-resisting iron. Consequently, the foundry quoting had a poor choice between losing the order or making it in ordinary iron, as others had done.

Irregularity Causes Indefiniteness.

In another case the castings were advertised as composed of special wear-resisting iron. The author analysed four of them and found them all different one from another. Hence he is unaware which of them, if any, was the special wear-resisting iron advertised by the makers. Special pistoning metals often exhibit similar variation, and it is not uncommon to find no two consignments alike or even identical throughout any one consignment.

It is bad for the industry that genuine high-class castings should need to compete with those for which the same claims are made without justification. The solution to the problem is for the engineer to have his specifications revised by metallurgists and to follow this up by taking precautions to see that the iron in the castings is up to those specifications.

Suppose a difficulty of the following nature arises. A foundry says it prefers not to work to the suggested specification because it has its own special iron. In that case the engineer should obtain a sample from an actual casting, ascertain its metallurgical properties and specify that all castings delivered shall be similar. Thus the purchaser will protect himself by making the foundry deliver its own standard iron and no other quality.

The leaders of thought in these matters are large consumers, such as automobile, electrical, hydraulic, railway and marine engineering works, the shipping firms, the Admiralty, the classification societies. All possible effort should be made to bring before the notice of these authorities the valuable work remaining to be done by them in metallurgically specifying cast iron; work long since done in the case of other metals and alloys, steels, gunmetals, bronzes and brasses, white metals and so on.

Chaotic Situation in Locomotive Cylinder Manufacture.

That high-quality iron is that which is always alike, suitable to the particular moulds and to the work the castings have to do, may appear to be obvious, but those possessing foundries do not always appreciate the great value and the economy to themselves of making such irons. In an effort to demonstrate this the author selects the subject of locomotive-cylinder manufacture. These are castings notoriously difficult to produce. For years past moulders have devoted close attention to them; no time, skill nor ingenuity has been spared to bring success. Yet to-day the locomotive-cylinder remains a mystery casting and runs of success are followed by periods of inexplicable failure.

* Paper read before the Newcastle Section of the Institute of British Foundrymen, Mr. C. Gresty presiding. The Author is a consulting metallurgist, 3, Central Buildings, Westminster.

The test-bar requirements are varied. A transverse bar of 2 by 1 in. section tested between supports 30 in. apart is common to this trade. Some specifications ask for a minimum load of 25 cwt., whilst others ask 30, 33 up to 40 cwt. The deflections going with these loads are sometimes 3/10 and sometimes ⅜ in. Others ask for a bar of similar section tested between supports 18 in. apart and here the minimum load is 55 cwt. and ½ in. deflection. Yet others specify supports only 12 in. apart with a load of 90 cwt. and deflections of 3/50, or sometimes 1/10 in. The tensile strength called for varies from 10, 12 up to 13 tons per sq. in. Some people ask for a crushing strength of 56 tons, others for 40 tons per sq. in. One authority specifies a minimum Brinell hardness of 180, no maximum being mentioned.

Such is the position of these specifications. The author points out that hundreds of different qualities of cast iron will pass them. As usual, they do not specify quality of iron at all—this is proved later in this article by comparing irons which have satisfied the tests.

The cylinders—the larger ones—may take 3 tons of metal to pour, of which about 10 per cent. is fettled or machined off. The machining allowances may be in the neighbourhood of about ⅜ on the bore and about 1¾ in. on the flanges and suchlike parts. The hydraulic test is not severe, being, say, 275 lbs. per sq. in.

Waster Losses.

Defects—apart from blow-holes, scabs and drawholes—consist of porosity on the flanges, porosity below and between the ports, porosity between adjacent cylindrical parts; leaky chaplets, occluded dirt or gas or sand or blacking. The cost of getting a cylinder through its final hydraulic test is frequently severe. Caulking, plugging and that peculiar operation called sal-ammoniacing are comparatively uncommon in the ordinary machine-shop, but in the locomotive-cylinder machine-shop they are almost accepted operations.

The percentage of wasters—namely, those castings which no amount of tinkering will make good—seldom will go higher at any one time than 30 per cent., or lower than 10 per cent., of the total cylinders cast; over years of working the average may be about 18 per cent. The percentage of cylinders which pass all tests without any tinkering may be 25 per cent. of the total passed.

The author speaks, of course, of the manufacture of all types of cylinders, and not of a foundry fortunate enough to make one type only. Some moulders claim that the secret of success is to cast vertically, others equally claim the same for the horizontal method.

Total Carbon Variations.

The author inspected some rejected cylinders when they were put under the ball, and what he saw was a revelation. In this connection it should be mentioned that in obtaining success in Diesel and suchlike work it has been his practice to have castings broken up and to observe closely the metal at those parts of the castings where trouble is experienced or where the iron is required to be at its best to withstand service conditions.

Later he obtained samples of cylinders made by two different foundries. These foundries have no connection with him, and he gives the figures below. The total carbon contents of the two lots of cylinders were as follows:—

	One Maker. Per cent.	Another Maker. Per cent.
One Cylinder ...	2.8	3.0
Another Cylinder	2.8	3.4
Another	3.3	3.7
Another	3.4	3.8
Another	3.4	3.8
Another	3.5	3.9
Another	3.5	—
Another	3.5	—
Another	3.6	—
Another	3.6	—

Here is a clue to the whole mystery. Porosity shouts from such figures. Softness, hardness, fluidity, wearing properties, density, and so on are mere guess work under such conditions. Yet each of these cylinders had passed the specified tests. Without any doubt whatsoever it points to the fact that while the moulder is doing his utmost to make good cylinders the cast iron is varying continually and defeating his efforts at every turn. In other words, the iron is allowed "to do what it likes." Apart from the plight of the foundryman, let us consider that of the railway engineer. He keeps elaborate records of test-results, wear, piston-ring trouble, resistance to super-heat, upkeep and so on, while the cast iron is rarely twice alike.

The author does not suggest that this state of affairs is common to the trade, he merely states as a scientific fact that the above results were obtained from cylinders made within a few weeks of each other by two foundries skilled in the locomotive-cylinder industry.

Control—The Remedy.

The solution to the problem is a simple one. Both founders and engineers will benefit enormously when the former control their cast iron and the latter metallurgically specify it. It means making standard iron, but if ever it were worth making it is in trades of this class.

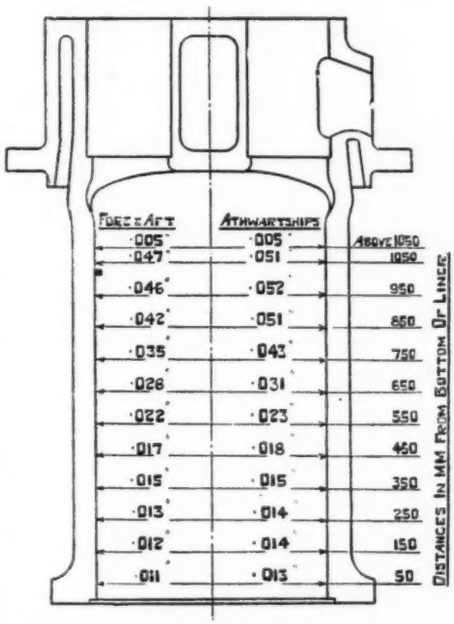


FIG. 1.—SHOWING THE MEAN WEAR OF EIGHT DIESEL ENGINE CYLINDERS AFTER 3½ YEARS' SERVICE. (BY COURTESY OF MR. SUMMERS HUNTER, C.B.E.).

At one time the author met a similar state of things in the case of marine cylinder-liners for superheated steam. No two were alike, and the dissatisfaction of users was universal. By studying what did and what did not wear well it became possible to produce a special iron and to keep it standard over years. No trouble has been experienced since, although dozens of liners and replace liners were made and have been on the sea for years.

Similarly with Diesel and all high-class work the problem is to ascertain and keep standard that iron which fills the moulds well, and which gives satisfaction under the conditions of the particular engine concerned. This will eliminate automatically a large number of the difficulties and mysteries of the maker and, also, of the user.

A Unique Experience.

Speaking of the troubles of users, one hears frequently of castings cracking in service, particularly in Diesel engineering. A remarkable fact, arising out of the production of high-class standard irons, is that during the whole of the author's experience, covering reciprocating, turbine and Diesel engine practice, he cannot recall an instance of a casting failing in service. He believes that had these castings varied as the locomotive cylinders, and as other irons to be mentioned later, varied, it would have been impossible to produce this clean record. It is better and cheaper to condemn a hundred castings before they leave the works than to have one fail in service or give bad service. That is self-evident to everyone who has had responsibility for high-class work.

Diesel Engine Cylinders.

There has been published recently the results of the wear of the cylinders of an eight-cylinder North-Eastern Diesel marine engine. These cylinders were 28¾ in dia. and 51¼ in. stroke at 92 r.p.m. During the past three and a-half years the ship, of about 8,000 tons D.W. capacity, has travelled 160,000 miles. Save piston rings, compressor and exhaust valves, no spare parts have been supplied; no single delay has occurred due to main or auxiliary machinery, and no work has been done in the engine room by other than the ship's engineers. The mean wear of all the eight cylinders after this 3½ years' service at a mean i.h.p. of 2,860 and a mean speed of 10.95 knots (on deeply laden voyages) is shown in Fig. 1 (reproduced by kind permission of the author's late chief, Mr. Summers Hunter, C.B.E., of the North-Eastern Marine Engineering Company).

More Variations Cited.

When considering claims for producing high-class cast iron it is necessary firstly to discover whether the foundry concerned has established that control necessary before it can make precisely the same iron year in and year out, and established it to that degree which enables it to make iron of any desired composition. As an example of the opposite may be taken the figures obtained from the books of a foundry making certain castings for important work, but carrying a considerable number of failures.

Period.	Variations in total carbon.	Variations in silicon.	Variations in manganese.
One year ..	From 3.2% to 4.0%	From 1.1% to 1.7%	From 0.5% to 1.2%
Another year..	From 3.0% to 3.9%	From 0.9% to 1.5%	From 0.5% to 1.4%
Another year..	From 2.9% to 3.7%	From 1.0% to 1.5%	From 0.6% to 1.2%

All the castings were for one particular purpose and had to pass the usual specification. It proves the futility of the specification when one realises that the majority of the above castings passed it.

Lack of appreciation of the metallurgical position arising from lack of proper specifications leads the engineer into many pitfalls. A year or so ago a firm purchased for its Diesel engines castings of an iron which the whole of the author's knowledge told him would be unlikely to give satisfaction. To-day, all those castings have had to be replaced by others. There is a steadily augmenting weight of evidence to show that controlled standard irons are high-class irons, and the only ones worth either making or using. "Perlit" iron belongs to this class, but it permits of the use of cast irons of compositions which are impossible under any other conditions.

As the author stated many years ago, and still believes, alloy cast irons will come, and he thinks it likely that the better alloy irons may be possible to produce only under "Perlit" conditions. It appears as if it will cost, roughly, an extra 40s. per ton to make cast iron containing either 0.25 per cent. of titanium, or 0.5 per cent. of chromium, or 1.0 per cent. of nickel.

Whilst retaining the scientific liberty of being able to change his opinion in accordance with new scientific facts and discoveries, the author is unable yet to see the need for alloy irons for heat-resisting purposes apart from those extreme conditions involved in such peculiar trades as, for instance, the making of moulds for the casting of articles in high-temperature glass. On the other hand, where resistance to erosion, to corrosion or to wear-plus-corrosion is necessary, the alloy series offer wide fields of possibility. In this connection it is useful to point out that the author's Paper upon corrosion by oil established the fact that much of the wear of piston rings, cylinder-liners, bearings, valve faces, and other parts of machinery

is caused probably by corrosion-plus-wear or corrosion-plus-erosion. Where cast iron needs to stand up (1) to fuel or spirit, or (2) to products of combustion, or (3) to the products of the action of fuel oil or spirit or lubricating oil (or the combustion products of any of these) upon certain other metals, there is every chance of corrosive action, which action may be, and is in many cases, transferred to the lubricating oil in the same engine. In certain instances, also, cast iron is called upon to withstand water or sea-water or air laden with such water or the results of the combustion of such air. The advocates of alloy cast-irons will not require to seek for markets when they can produce the goods.

Low Carbon Irons Fail to Reach Expectations.

Low-carbon cast irons have not done as well as people expected. There is something peculiar about them in that their strength is no greater, and usually lower, than that of higher-carbon iron. This is a point of which research workers and engineers should make a note. The author has examined many castings made of low-carbon iron and found that its tensile strength varies between 13¼ and 16¾ tons per sq. in., as against 16 to 21 tons for higher-carbon irons in similar castings.

All low-carbon iron is not standard iron. Fourteen castings examined by the author gave the following amounts of total carbon:—(1) 2.4; (2) 2.4; (3) 2.5; (4) 2.5; (5) 2.5; (6) 2.6; (7) 2.6; (8) 2.7; (9) 2.7; (10) 2.7; (11) 2.8; (12) 2.8; (13) 2.8; and (14) 2.9 per cent.

Hence, in this high-priced iron the total carbon, namely, the only special thing about it, varied from 2.4 to 2.9 per cent. in one batch of castings.

A large casting (about 3 per cent. tons weight) made of this same iron happened to be condemned, and the author was able to obtain six tensile bars from various parts of it. The bars were cut in pairs, and the results were as follows:—

13.9 tons	7.9 tons	12.6 tons
13.4 tons	7.0 tons	12.6 tons

As a comparison with this expensive material made only last year may be taken the results, published by the author in 1925, of a similar casting made of standard higher-carbon iron. The average tensile of seven bars cut from the top of the casting was 18.34 tons, and of seven bars cut from the bottom was 16.69 tons.

Still More Variations.

Recently the author inspected a heavy cylinder-liner casting, said to be made of "special" metal, and for which a high price had been paid. It contained 0.9 per cent. of silicon. A similar casting, made by the same foundry, and lying alongside the other in the machine shop, contained 1.6 per cent. of silicon. This variation in two similar and heavy castings caused the author to examine seven light castings made by that foundry, and delivered at or about the same time as the two heavy ones. The results are instructive.

	Silicon Content. Per cent.
One Heavy Casting ...	0.9
Another Heavy Casting ...	1.6
One Light Casting ...	1.0
Another Light Casting ...	1.2
Another	1.5
Another	1.7
Another	1.7
Another	1.8

Thus it became evident that the metal was not "special" at all, being whatever the furnace happened to be giving, and poured into whatever mould happened to be ready, irrespective of the weight or purpose of the casting concerned.

Here, again, the engineer's records of wear and other data obtained in service were rendered valueless by reason of the constant variations in the quality of the iron.

Specifications Desired.

In these days when engineers are thirsting for heat-, wear- and impact-resisting irons for parts of modern engines, oil-burning and stoking gear, wheels, coke ovens, furnace doors, valve guides, firebars, railway chairs, carbonisation plants, and a thousand and one other purposes, it is time that foundrymen told the mthat such irons can be produced with no small success. On the other hand, the foundries making the irons and the engineers purchasing them will never have a sporting chance so long as the irons are not properly and metallurgically specified.

A foundry making high-class iron in a genuine manner is not afraid of working to metallurgical specification, but under the present conditions it is ever in fear of the competition of others who may not be doing it properly, and where no specification exists to prove it.

Claims for producing a high-quality iron carry no weight until one knows the properties which that iron possesses in each and every casting produced. Let engineers adopt proper specifications for cast iron, and British foundrymen and metallurgists will respond loyally and capably to this long-delayed and much-needed encouragement.

This Paper being read before his old Branch, the Newcastle Branch, the author desires to conclude upon a personal note. He believes that the reputation of this Branch—a reputation second to none—will grow indeed if it will undertake the work of planting and forcing into strong growth the seed of knowledge that the time is overdue for specifications of high-class cast iron to be made metallurgically correct and sound for the mutual protection of both makers and users. His endeavour, in outlining these matters, has been to carry on a little further the road which others will complete.

International Association for Testing Materials.

Some months ago a British Committee, consisting of representatives of some of the most important Engineering and Technical Societies and Institutions of this country, was formed for the purpose of arranging British participation in the above Association, which has been established as a result of the Amsterdam Congress of last year. This Committee has recently issued an appeal to members of its Constituent Societies to join the New International Association. Recently also the Permanent Committee of the New International Association held its second meeting in Paris (June 21), and arrived at a number of important decisions affecting the future conduct of the Association and its Congresses.

Object of the New Association.

The main object of the Association is to hold periodical congresses, and the Permanent Committee have devoted their attention almost exclusively to that question. Experience of past Congresses, both at Amsterdam last year and the earlier gatherings of the old International Testing Association, has led to the conviction that it is unsatisfactory at a single congress to discuss subjects covering the whole range of the testing of materials, and that it is necessary, if a satisfactory and fruitful discussion of pressing problems is to be facilitated at a congress, to confine attention to a relatively small number of subjects in each of the sections into which the work of the Congress is to be divided. Important decisions were taken at the Zurich meeting of the Permanent Committee, held in January last, when it was decided to divide the work of the Congress into four sections, namely, Section A, Metals; Section B, Inorganic Non-metallic Materials; Section C, Organic Materials; and Section D, General Methods of Testing. While making this subdivision of subjects, it is the view of the Permanent Committee that undue specialisation in the treatment of important questions by International discussion is undesirable, and that, as far as circumstances permit, the meetings of the four Sections of Congress should not overlap except where very highly-specialised points are under discussion. This arrangement will enable members participating in the Congress to interest themselves in matters of any Section. It has been strongly urged that the methods of testing used for one class of material are often of interest and importance in connection with other types. The activities of Section D of the congress should be particularly valuable in this connection.

Methods of Selection.

Having adopted the principle of confining the discussions to be held at any individual Congress to a small number of specially important subjects, the Permanent Committee is faced with the difficult task of selecting the particular subjects in each group, which are to be reported upon and discussed at the next Congress. With a view to providing ample time for the preparation of reports and discussions, although the next Congress is not to be held until 1931 (at Zurich), the Permanent Committee in January last issued an invitation to all the participating countries to forward suggestions for subjects for discussion to be considered by the Permanent Committee at their meeting in June. This invitation provoked a very lively response from sixteen countries. A very large number of suggested subjects were put forward. Suggestions ranging in number from 40 to 60 had been received for each of the four groups.

Present Position.

An invitation is about to be issued, through the delegates of participating countries who are members of the Permanent Committee, inviting each country to prepare a number of preliminary summarising reports on a small number of selected subjects. Out of the long list of suggestions which were before the Permanent Committee, a selection has been made of about 10 subject headings with a few sub-headings, for each of the groups. A list of these headings is being sent to each country and the local Testing Association or equivalent organisation is being invited to select a few of these subjects and to appoint reporters for the purpose of preparing the preliminary report for which the Permanent Committee have asked. While these preliminary reports are intended to serve as a basis for the final selection of subjects and reporters for the Zurich Congress in 1931, it is proposed to publish these preliminary reports, since they will constitute a valuable collection of data and opinions on important questions relating to the work of the New International Association. This publication will, it is hoped, be possible early in 1930. Each of the Reports will be published in one of the official languages of the Congress (English, French and German), but it will be open to any nationality to have their own Reports printed also in their own language, provided that the National Organisation in such a case bears the additional expense entailed.

Final Selection.

When, towards the end of 1929, the Permanent Committee has before it the whole of these preliminary reports, it will be in a better position to consider the final selection of subjects, and of those who may be invited to prepare Congress Reports upon them. These Congress Reports, again, will be circulated to members intending to take part in the Congress, so that the whole of the time of the Congress itself can be devoted to free international discussion of the questions treated.

The International Association is adopting a difficult and laborious course of preparation for the work of the Congress of 1931, and it is hoped that the results achieved by that Congress will justify the amount of time and trouble thus devoted to its preparation. In the past, the activities and interests at international congresses of this kind have been too widely scattered over a great range of subjects, each of which has had to be hurriedly and inadequately treated in discussion. By the process of the preparation of preliminary reports and a careful subsequent sifting of subjects, and the selection of those most likely to be of general interest and importance, it is hoped to achieve a thoroughly satisfactory discussion of a limited range of subjects.

With regard to British participation in the work of the New International Association for Testing Materials, it may be mentioned that the British Committee is taking active steps to secure widespread membership among those interested in the testing of materials in this country.

Adding Nickel to Cast Iron.

We are indebted to the Bureau of Information on Nickel, Limited, of the Metal Exchange Buildings, Leadenhall Avenue, London, E.C.3, for sending us the accompanying illustration of the apparatus required for making additions of nickel to cast iron. The particular apparatus shown is of special interest in that it is in regular daily use in a large foundry in the Midlands. It consists, essentially, of an inverted sheet-metal funnel having a hole (about ½ or ¾ in. diameter) at its apex which can be sealed by a movable metal rod. A weighed quantity of nickel shot (nickel-silicon containing about 92 per cent. nickel is recommended) placed in the funnel, can be added

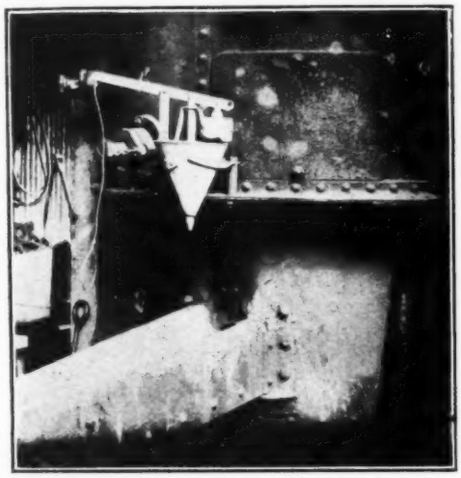


FIG. 1.—A MECHANICAL DEVICE FOR ADDING ALLOYS TO CUPOLA MELTED CAST IRON.

gradually to the stream of metal issuing from the cupola by pulling the wire attached to the stopper.

The funnel is so placed that the shot falls directly into the stream of iron at a short distance from the tapping hole, and the apparatus is supported so that the apex of the funnel is about 15 in. above the metal stream. This gives the shot sufficient impetus to force it well into the iron, and therefore ensures a thorough mixing.

The addition of nickel is commenced as soon as the iron fills the ladle to a depth of one or two inches, and is continued at a constant rate until the ladle is about half full. Such a method gives satisfactory mixing and therefore a uniform product.

New Type of Engine.

Clyde Ship the First to Use it.

The Blythswood Shipbuilding Company launched from their Scotstoun yard on Friday a new motor ship, the *Irania*, which will be the first vessel to be equipped with a type of Diesel engine designed and produced entirely in Britain.

The engine is the result of three years' research work by Messrs. Richardsons, Westgarth & Company, Limited, Hartlepool, and has not yet been tried on the sea, but workshop trials have completely satisfied the makers as to the utility of their product.

The engine is of the two-stroke double-acting type, with three cylinders instead of the usual six. It is fitted with a new system of fuel pump for solid injection, whereby all intricate parts are under the eye of the engineer.

Advantages of the new type are that the weight is roughly 60 per cent. of the weight of the ordinary oil engine of to-day, and that the length is approximately 60 per cent. of the usual.

It has been evolved specifically to be manufactured in the ordinary marine engineering shop as simply as a steam engine and at a comparatively low cost.

Nottingham Foremen at Dinner.

There was a large gathering at the annual dinner of the Nottingham branch of the Foremen's Mutual Benefit Society, held at the Arboretum Rooms, on Friday evening. Mr. R. Sims (President) occupied the chair.

In toasting "The Society," Mr. Sims referred to the efforts made towards peace in industry, and said that whether we should ever have peace in industry might be an open question. He was not sure that was an object they really wanted to attain. What they did want was goodwill in industry. Good understanding between employers and employed was to a very large extent in the hands of the foremen. It depended how they handled the men and listened to their grievances, whether they had a peaceful atmosphere in the shop. "We, as employers," he said, "are desirous of giving our workpeople a fair and square deal; but our efforts may be fruitless unless we are backed up by men of vision and sympathy, who can foster the spirit of goodwill, without which peaceful progress will be absolutely impossible."

In responding, Mr. Biggart said that progress was still the keynote of the position of the Society. They had now funds amounting to £1,700,000, and investments approaching £1,600,000. The membership was 15,000. A sum of £1,300,000 was required for the pension obligation of the Society. In 29 years the sickness claims of the Society had only been 66 per cent. of what was expected, and death claims only 47 per cent. With regard to the question of peace in industry, he said, they would not achieve that by taking the question out of the hands of those who were intimate with it, and calling in people who did not know the first elements of what was involved in the problem. If both sides set about solving that problem with understanding minds they would have that better understanding, that energy and vigour that would bring back our old country to be again the leading industrial nation of the world.

Scotland Prepares to Entertain Overseas Visitors.

The local branch of the Institute of British Foundrymen is actively engaged in preparing for the reception and entertainment of the overseas delegates when they visit Scotland next June. An influential Reception Committee has been formed, with the Right Hon. Lord Invernairn of Strathnairn as President, supported by a number of vice-presidents, including Sir Archibald M'Innes Shaw, C.B., LL.D., the Lord Provosts of Glasgow and Edinburgh, Sir John S. Samuel, K.B.E., Sir Frederick L. M'Leod, K.B.E., Capt. H. J. Kennard, R.N., the Presidents of the Chambers of Commerce of Glasgow and Edinburgh, Mr. L. P. McKenzie, Mr. John Cameron.

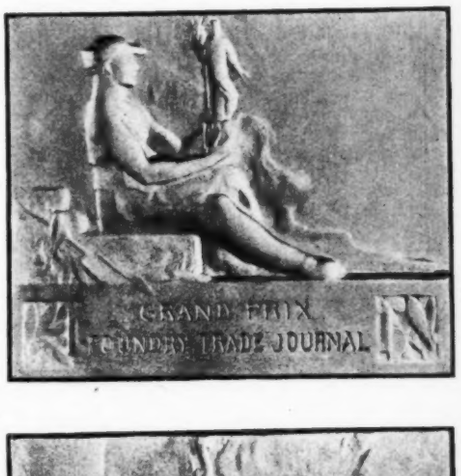
The visitors are assured of a most cordial reception, and the fact that the detailed arrangements for their entertainment is in the hands of the same executive committee (Messrs. J. Affleck, John Bell and A. Campion) that successfully carried through the 1925 convention, ensures the comfort and convenience of the guests during their stay.

Trade Union Merger Scheme.

The Scottish officials of the Transport and General Workers' Union and the Workers' Union have arranged a campaign among the Scottish members in support of a scheme for the amalgamation of the organisations. Over 35,000 members in Scotland are affected by the negotiations, and the proposals have aroused considerable interest among the workers. The National Minority Movement are opposing the amalgamation on the ground that it is in line with the recent industrial peace propaganda and conference between the General Council of the Trade Union Congress and the Mond Group.

A Recognition.

At the International Foundry Trades' Exhibition, held in Paris in September last year, THE FOUNDRY TRADE JOURNAL was awarded a Grand



Prix. As a souvenir of the honour accorded to us, the management committee has sent us a small plaque, reproductions of which are shown above.

Derby L.M.S. Works Go On Full Time.

There is still more good news for the foundry workers of Derby, and, so far as the L.M.S. is concerned, full time working conditions commenced on Saturday last. This news has been received with delight by the thousands of railway workers in Derby, for it will mean normal employment after a long spell of short time.

For a considerable period now the works have been employed, generally speaking, on only five days per week. It was a circumstance which the shopmen considered should have been taken into account when the 2½ per cent. all-round reduction was decided upon some months ago, but it was pointed out at the time that the acceptance of the agreement would avoid dismissals on a serious scale. How long the full-time working will be continued is not known, and employees have to be content for the moment with the announcement "until further notice."

Patternmakers' Secretary.

The Clyde branches of the United Patternmakers' Association have re-elected Mr. J. L. Richmond organising secretary for a further period of three years. Mr. Richmond is also chairman of the Industrial Advisory Council, the educational organisation for trade union officials in Glasgow.

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Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Transverse Tests.

To the Editor of The Foundry Trade Journal.

Sir,—May I call the attention of your numerous correspondents to the fact that the "beam paradox" was dealt with many years ago by the late Sir Benjamin Baker in a Paper published in the Minutes of Proceedings of the Institution of Civil Engineers. Sir Benjamin had found that in the case of a fairly homogeneous material like rail steel, the beam formula gave for rectangular sections value 70 per cent. in excess of the ultimate tensile strength obtained by direct pull. Hence all values obtained by the lever test—as it was called—had to be divided by 1.70 in the case of rectangular sections to arrive at the corresponding ultimate strength in direct pull. In the case of a rail section the excess of 70 per cent. had to be reduced according to the proportion of the actual area of the rail section to the area of the circumscribed rectangle. Take, for instance, an F.B. rail having an area of 3,800 sq. mm.; area of circumscribed rectangle = say, 12,600 sq. mm.; hence the excess in the value obtained by the beam formula would be in this case:—

$$\frac{70 \text{ per cent.} \times 3{,}800}{12{,}600} = 21.11 \text{ per cent.}$$

Consequently, the theoretical value obtained by the beam formula had to be divided by 1.2111 to arrive at the corresponding value of the ultimate tensile strength of the steel in direct pull.

Needless to say the lever test was of very little use; it got gradually neglected, and was finally dropped altogether as worse than useless. Cast iron, of course, constitutes, a more complicated case than rail steel.—Yours, etc.,

Railway Engineer.

Boosting Glasgow.

In the hope of attracting new industries to the city, Glasgow Corporation authorised the issue of a brochure detailing various trades carried on in the city. In a preface to the volume, which has just made its appearance, Mr. Stenhouse, Town Clerk, gives a brief *résumé* of the part the municipality has played in the commercial development of Glasgow, and states that the Corporation to-day is no less alive than in bygone days to the importance of a keen and practical interest in the city as a commercial centre. The Lord Provost (Sir David Mason), Sir Robert Horne, M.P., Councillor John S. Clark, Sir John S. Samuel and Professor Scott contribute to the brochure. Copies of it may be obtained free on application to the Town Clerk.

Book Review.

The Future of Tin.—A short statistical and critical analysis of tin shares, and the tin industry for investors. H. Oakley and E. Pritchard. St. Catherine Press. 39 pp. 6d. The title of this pamphlet indicates adequately the scope and aim of the work. Those who are interested, either from the financial or academic point of view, in statistics concerning the production and consumption of tin, will find this a very valuable addition to their reference files. Numerous curves drawn from these statistics greatly enhance the value of the work, although it seems a pity that these had to be based on information obtained abroad. The future of tin is, however, principally left to the imagination, which, we presume, is intended to be inspired by the information given, to the temporary detriment of our bank balance.

Trade Union Fees Reduced.

The United Patternmakers' Society Executive have decided to reduce the weekly contributions for ordinary members from 2s. 3d. to 2s. from the beginning of the first quarter of 1929.

Derby Engineers Dine.

There was a large gathering at the annual dinner of the Derby Society of Engineers, held at St. James's Restaurant, over which Sir Henry Fowler (President) presided.

After the Mayor had offered his congratulations to the Society on the work achieved last year, and wished them success during the present session, the toast of "The Society" was drunk, on the call of Councillor A. Sturgess, and, in replying, Sir Henry Fowler said the engineers belonged to a most notable Society.

Further tribute to the Society was paid by Sir Richard Luce, who responded to the toast of "The Visitors." Most of the development in engineering had taken place in the last 150 years, and in that time the condition of the world had completely changed.

At a whist-drive, held later in the evening, prizes were won by Mrs. Hornbuckle and Miss Kidger and Mr. Househam and Mr. Munns.

The Steel Sleeper Contract and the Foundry Industry.

Founders in general were not at all clear in their minds from the description of the recent substantial order placed by the Southern Railway for steel sleepers, as to whether cast-iron chairs would still form part of its final make-up. In an interview with Sir William Larke, K.B.E., director of the National Federation of Iron and Steel Manufacturers, our representative was informed that the type ordered was the "Sandberg," which eliminates the use of chairs. Thus only the foundries catering for steelworks and rolling mills will benefit, and these only to a limited extent.

Clyde Shipping Output.

Twelve vessels, aggregating 56,602 tons, were launched on Clydeside during November. The total for the 11 months is thus brought to 556,972 tons, which is the best since 1920. Prospects for the New Year are considerably brighter through the placing of substantial orders during the last two or three weeks, these including a liner of 40,000 tons to be built by Messrs. John Brown & Company, Clydebank, for the Canadian Pacific Railway Company. The most important of the launches was the *Northern Prince*, a passenger vessel of 11,200 tons, constructed by Messrs. Lithgows, Limited, Port Glasgow, for the Prince Line.

Falkirk's New Bailie.

Captain H. J. Kennard, R.N., managing director of the Falkirk Iron Company, Limited, who was recently appointed Junior Magistrate of the Burgh of Falkirk, made his first appearance at the local police court last week. He was introduced by Bailie Logan, who said that it required very few words to state what Bailie Kennard was or had been. He thought it would be difficult to find a time during which there was not a Kennard prominently connected with the town of Falkirk.

Mr. A. Balfour Gray, assessor of the court, and Mr. J. G. Morrison, burgh prosecutor, also welcomed Bailie Kennard, and assured him that the officials of the court would give him every assistance in performing the duties.

Contributions to Charities.

During the twelve months ending October, 1928, the employees of Messrs. Babcock & Wilcox, Limited, at Renfrew, have contributed £2,007 to various benevolent institutions in Glasgow and the vicinity.

New Justice of the Peace.

Included in the latest list of additions to the Justices of the Peace for Glasgow is the name of Sir Alexander Kennedy, of the Fairfield Shipbuilding and Engineering Company, Limited.

Random Shots.

The loss of the "Vestris" has occasioned even more public attention than most tragedies of the sea usually arouse even in this country. Although she plied between New York and South America, she was British owned, and one of the few Englishmen who has travelled on the ship says she was a smart and comfortable boat.

* * *

Then the story itself and the spectacular rush of rescuing vessels on receipt of the S.O.S., and some remarkable photographs of the ship while sinking combined to draw attention to the disaster. Large vessels are regarded to-day as so safe that such a happening is apt to come as a shock.

* * *

The British Press has been justifiably indignant at the way in which the attorney has been conducting the inquiry, for his behaviour resembles that of prosecuting counsel rather than judge. I was greatly interested to see one of the leading New York papers asking that the whole matter be left in the hands of the British Board of Trade, which had a world-wide reputation for thoroughness and impartiality in these matters.

* * *

I note from an announcement in the Press that one of those lost in the vessel was Mr. Miller Watson, the son of Mr. M. Watson, manager of the Mount Vernon Iron & Steel Works, Shettleston, near Glasgow. The sympathy of the whole industry will go to Mr. Watson and family in their tragic bereavement.

* * *

If you are called upon to speak at a dinner earlier than is mentioned in the programme, a good story with which to begin is that of the little boy who was found sitting pensively on a doorstep while the other children were playing inside the house. "Why," asked a visitor, "don't you go in and play with the others?" "I musn't," was the reply, "I am going to play the baby, and I am not born yet."

* * *

Then to finish up your speech, there is the one which puts the old Eastern riddle, "Which is the happier, he with a million of money or he with nine daughters?" The answer is, "the man with nine daughters, because he wants no more."

* * *

He was looking for a quiet place to park his car, and seeing a side street, turned into it, drew up, put the brake on, and was just walking off when a policeman appeared on the scene.

"'Ere, you can't leave that car there!"

"Why not? It's a quiet spot."

"I tell yer, yer can't leave it there."

"But, my good man, it's a *cul-de-sac*."

"I don't care if it's a Rolls-Royce—bring it out!"

* * *

The alphabet progresses slowly, but here are a few more. We have now, you remember, got as far as S.

T is for Temperance, which we support,
With every action and every thought.

U is for Umbrage, which you musn't take
If ever the foreman points out a mistake.

V is for Velvet, upon which we lie,
So fine are conditions in every foundry.

W is Work, and if you don't know it,
Anyone in the trade will speedily show it.

Marksman.

Eutectic Cast Iron.*

By A. Mitinski.

Cast iron being an aggregate of metal and graphite, its properties were dependent upon: (1) the relative proportions of these two components; (2) their form and distribution; and (3) the properties of the metal and even, it might be said, of the graphite (specific gravity, crystallisation). Inclusions of graphite weakened the metal to an extent varying with their form and distribution, just as the form and distribution of the mica affected the mechanical properties of granite. The metallic skeleton of ordinary cast iron was a more or less hard steel containing silicon, phosphorus and manganese in such large quantities that even in the absence of graphite good mechanical properties could not be expected. This steel, moreover, was rough cast and unannealed, and it was due to the presence of graphite that it was not generally subject to too coarse crystallisation. Malleable cast iron was the only case in which this skeleton was a steel treated thermally and of a suitable chemical composition. In that case the graphite was distributed in small nidae of a form favouring good properties.

Malleable cast irons showed greater tensile strength, but lower transverse and compression strength than good grey cast iron; the graphite in the latter was, in fact, useless as regards tension, but was a good inductor of compression strength. The matrix itself, of grey cast iron, containing more pearlite than that of the malleable metal, possessed greater strength. If a cast iron had a pearlitic matrix its total strength was at a maximum provided the graphite was distributed regularly in a non-lamellar form. If this condition was not fulfilled the distribution of the internal stresses (influenced by the external stresses) was irregular and the strength of the metal was diminished. The mechanical resistance of any casting to external stresses was largely dependent on the distribution of the tensions caused by these stresses. This distribution was dependent not only on the shape of the casting and the extent and distribution of the stresses, but also on the homogeneity of the metal itself. In this complex aggregate of hard and soft particles it was impossible even to define the distribution by the rules of ordinary statics. In any case, as each part of the casting had a resistance greater or less than its neighbour, this produced an irregular distribution of the internal stresses and a non-homogeneity in the "field of forces," while the local stresses might be greater than the mean stresses.

A homogeneous casting showed greater resistance to external stresses than a heterogeneous casting of the same metal having very strong parts. It was necessary, however, to make an exception in cases where small particles of a very resistant constituent were distributed very uniformly in large quantities (tempered steel, aged duralumin, etc.), as in the case of quasi-isotropic metals. A casting could be very strong only if its structure was quasi-uniform.

There were two methods of obtaining cast iron possessing excellent mechanical properties. The first consisted in reducing the total carbon to less than 3 per cent. in order to have a less quantity of graphite. The skeleton was then less discontinuous; the desired graphitisation was obtained either by malleabilisation or by means of high-silicon contents—a method which was not suitable for thick castings. The second method consisted in reducing the silicon content and obtaining the desired graphitisation by casting in previously heated moulds. This was done in the case of so-called "perlit" cast irons. The pearlite constituting the entire skeleton of the metal, moreover, did not contain 0.89 per cent. of carbon, as 1 per cent. of silicon reduced this content to 0.67 per cent., while 2 per cent. of manganese would bring it down to 0.75 per cent., etc.

If the graphite in cast iron was non-lamellar and uniformly distributed, the presence of ferrite (uniformly distributed) increased its ductility, its resistance to shock and its machining qualities. The great aim to be achieved, therefore, was uniformity in the casting. This homogeneity was dependent upon the uniform distribution of the chemical elements and the uniform decomposition of the cementite. A casting poured with non-pearlitic metal always showed chemical heterogeneity as a result of the solidification period. If the metal was hypo-eutectic, the crystals (dendrites) which solidified first were less rich in carbon (while containing different quantities of Mn, Si, P, etc.) than eutectic metal. In the first case the graphitisation of the primary solid solution produced large graphite lamellæ, as the graphitisation of the primary cementite did in the second case. The best graphite was that produced by the graphitisation of the pearlite.

It was therefore eutectic cast iron that showed on solidification the most uniform distribution in the castings of all the elements in the metal. If the phosphorus content was sufficiently high the best distribution of the ternary eutectic was also obtained in that case. Similarly, from the point of view of the distribution of the graphite (apart from the question of its form), the result of the absence of silicon concentration in the parts solidified last was that there was no increase in the slowness of cooling which would accentuate the graphitisation in these parts. Finally, as the melting point of eutectic cast iron was minimum the application of super-heating treatment was commercially easier than in the case of other cast iron.

The results of transverse tests on test pieces of hypo-eutectic cast iron might be better than those of eutectic cast iron, as during this test only the external fibres of the bar were stressed. It was not, however, the strength of test pieces that mattered, but that of the castings themselves. Hyper-eutectic cast iron could not give high-resistance castings, as the graphitisation of the primary cementite produced too coarse a structure with large graphite lamellæ. Foundry pig-iron from coke and hot-blast blast furnaces being hyper-eutectic, it was easy to see what improvements could be effected by adding scrap in the cupola. The only advantage of castings of hyper-eutectic cast iron was the ease with which they could be machined.

On remelting, the nuclei of primary graphite were generally not dissolved in the liquid metal produced by the cupola. It was only by effecting several successive meltings or by employing the electric furnace that it was possible to suppress the very harmful influence of these beginnings of graphitisation. Pure iron-carbon eutectic contained 4.3 per cent. of carbon, and in technical literature it was not uncommon to see alloys which merely contained less than 4.3 per cent. of that element described as "hypo-eutectic cast iron." Here it must be remembered that commercial cast iron was not a pure iron-carbon alloy, but a complex alloy of iron, carbon, silicon, manganese and phosphorus subjected to the following influences. The silicon greatly reduced the carbon content of the eutectic. The researches of Wüst and Peterson, K. Honda, Murakami, Gontermann, and others showed that 1 per cent. of silicon reduced that content to 3.88 per cent. C., 2 per cent. to 3.63 per cent. C, and 3 per cent. to 3.3 per cent. C. According to Wüst and Peterson, manganese, so far as ordinary contents were concerned, exercised no influence on the eutectic content in carbon. Phosphorus, according to Wüst, reduced it by about 0.3 per 1 per cent. of P. The simultaneous influences of silicon and phosphorus were not precisely known, but everything led to the belief that these were additional influences.

In accordance with these data it was possible to ascertain fairly approximately the eutectic carbon content of commercial cast iron of a given chemical composition. Thus, the Automobile Builders' Association recommended for that industry a cast iron of the following composition: Carbon, 3.25 to 3.50 per cent.; manganese, 0.4 to 0.7 per cent.; silicon, 1.9 to 2.2 per cent.; phosphorus, 0.6 to 1 per cent. It would be seen that this was practically a pearlitic cast iron. The eutectic content of cast iron with 2 per cent. Si and 1 per cent. P, would, in fact, be 3.63 – 0.3 = 3.33 per cent. C. That of cast iron with 2.2 per cent. Si and 0.6 per cent. P, would be 3.56 – 0.18 = 3.36 per cent. The formula recommended by the Association was therefore justified by theoretical considerations. The old rule applied by practical men for thick constructional castings was:

$$C = \frac{4.2 - Si}{1.3}$$

In British practice the following formula was often employed:—

$$C = K\ 4.26 - \frac{Si}{3.6}$$

in which:

K = 0.9 to 1 for pipes, machinery castings, etc.,
K = 0.83 for locomotive cylinders,
K = 0.7 to 0.82 for motor cylinders.

As would be seen, these two empirical formulæ approximated to eutectic compositions, but took no account of the phosphorus content, and the fact that the influence of the silicon was not proportionate to its content. It might also be pointed out that the diagrams of E. Maurer and P. Koltzhausen showed that the best pearlitic metals were obtained by means of eutectic cast iron.

Once the principle was laid down that eutectic cast iron shows the best distribution of graphite, the questions relating to the form and amount of the graphite still remained to be examined. For this purpose it was necessary to adjust the silicon content to the thickness of the castings, and the figure obtained, together with the phosphorus content, was employed to determine the eutectic carbon content. The cooling speed of the castings could be reduced by previously heating the moulds, in which case the silicon content was reduced and the carbon content increased.

Pearlitic cast iron was sometimes referred to as a recent discovery. Anything that had been practically forgotten might well seem new later on. Our ancestors used to cast their cannon with eutectic cast iron, the metal being a charcoal cold-blast pig remelted in the reverberatory furnace and cast in preheated moulds. It was interesting to recall the fact that they even knew the value of cores cooled by currents of water or air, which were now in such esteem with founders of automobile cylinders, and with which our ancestors used to obtain a better internal surface grain in their cannon.

The author believes that at no distant date hyper-eutectic cast iron would disappear and that the electric furnace, by eliminating FeO and the germs of primary graphite, while increasing the fluidity of the metal, would enable the silicon and phosphorus contents to be reduced. We should then get nearer and nearer to the old cast irons, rich in carbon and poor in silicon, the eutectic cast irons of our ancestors.

* Paper presented to the Paris Foundry Congress, 1928. The author is Professor at the School of Mines in Pribam, Czechoslovakia. (Exchange Paper from the Foundry Association of Czechoslovakia).

Light Ironfounders' Wages Reduced.

Negotiations are almost completed between the National Light Castings Ironfounders' Federation and the Light Metal Trades Unions Joint Committee for the revision of wages of men employed on rain water goods. It has been jointly recommended that a reduction of 5 per cent. on the present rates should be accepted by the men. The employers have suggested that the reduction should operate from December 3, and the unions have proposed January 1. The date is now under consideration.

The change follows on the reduction of wages agreed to for other classes of workers in the industry last September. The men concerned are mainly employed in the ironfounding industry in Falkirk, Bonnybridge and Stirlingshire districts and in the Midlands of England.

Died at Work.

Whilst at work in the Lanarkshire Steel Works, Flemington, Motherwell, David Cutler, a roll worker, collapsed and died before medical assistance could be obtained.

E

Internal Stresses.*

By A. Le Thomas.

M. Le Thomas prefaced his Paper by remarking that a volume as interesting as a novel might be written on internal stresses in metals and their alloys if the phenomena to which they gave rise could be described in detail and fully explained. Everyone, for example, had seen the bursting of a milling cutter in high-speed steel, its fragments being projected to a distance of several yards by enormous stresses the existence of which could not in any way have been foreseen a moment before. Another interesting case was that of ships' shafts (six to ten metres in length) which were subject to considerable deformation when being turned unless special precautions (stabilising thermal treatment) had been taken. These shafts often showed a deflection of several millimetres after the first pass, and then another deflection as great, but frequently in a different direction, after the second pass, etc. This would explain the anxiety of the engineering staff, which approached desperation when the thickness of the turnings to be removed approached zero, while the shaft continued bending in arcs of the most diverse description. Experience showed, however, that the deformations diminished in proportion to the thickness of the peripheral layer removed, which suggested that the stresses were localised near the surface. The case of special steel blooms might also be cited, those of nickel-chrome, for example, which were, in fact, used for forging the shafts he had just mentioned, and which when heated carelessly "went off" with a violence suggesting an explosion.

A more complex case than these was that of the "season cracks" in brass. Among brass rods or tubes that had been stored, after having been found perfectly sound, it was not unusual to find a greater or less proportion of them cracked. Following several authors, for the most part British, de Leiris, a friend and former collaborator of his, had investigated this mysterious phenomenon, certain manifestations of which, from their irregularity or their sequence, seemed absolutely fantastic. Apart from the conclusive experimental proofs† adduced of a theory explaining the phenomenon, the importance of his work consisted in his having shown that the action of stresses, which was sometimes apparent only after an interval of several years, could be stimulated by subjecting the articles suspected of containing them to the action of a reagent. In this way it could be known at once whether the articles were sound or not.

This, however, was rather removed from the subject he wished to examine, which was limited to cast iron. He intended to indicate later how the stresses affecting a casting might be cured. Then, as in the majority of cases it was not easy to act as he recommended, he proposed to take advantage of the Congress to raise a question of a general nature with reference to the responsibility of founders in the case of accidents resulting from internal stresses.

The Suppression of Internal Stresses in Castings.

The existence of internal stresses in castings was a very serious evil, the more so as it was generally impossible to detect. The action of these stresses was added to the normal fatigue due to the forces stressing the casting while in use, and there were not a few cases of rupture, apparently spontaneous, which must be attributed to them. In other cases the casting was deformed when it was heated, owing to the stress field being modified. This occurred with the stators of turbines, the play of which in relation to the rotor might be dangerously diminished. To prevent these stresses it had been recommended that castings be shaped so that their thickness should be as constant as possible, in order to ensure uniformity in cooling, and that steps be taken to enable the action of the contractions, which were further complicated by the peculiarities of expansion, to take place easily in the mould in the process of cooling subsequent to casting.

There were certain cases, however, in which the application of such precautions, if not actually impossible, was beset with difficulties owing to the nature of the casting. He had endeavoured to ascertain whether stresses could be eliminated from a casting affected by them by applying a suitable stabilising treatment. The test piece he selected for this investigation was an eccentric rim, the external diameter of which was 60 mm. and the internal diameter 40 mm., while the centres were 6 mm. apart. The test piece was 20 mm. long. Moreover, to aggravate the stresses the thin portion was cast close to a chill. Several test pieces were obtained concentrically and simultaneously in the same mould in order to secure perfect homogeneity of metal in a single series of tests (Fig. 1). The alloy forming this casting was a high-tensile cast-iron with a pearlitic structure, such as is used in machine construction. It gave the following analysis:—T.C., 3.38; C.C., 0.73; Si, 1.74; Mn, 0.83; S, 0.10; and P, 0.25 per cent.

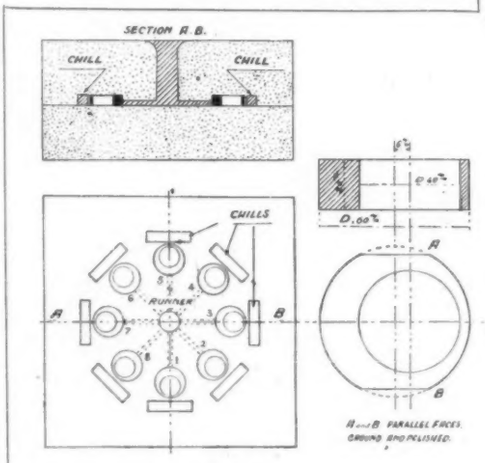


Fig. 1

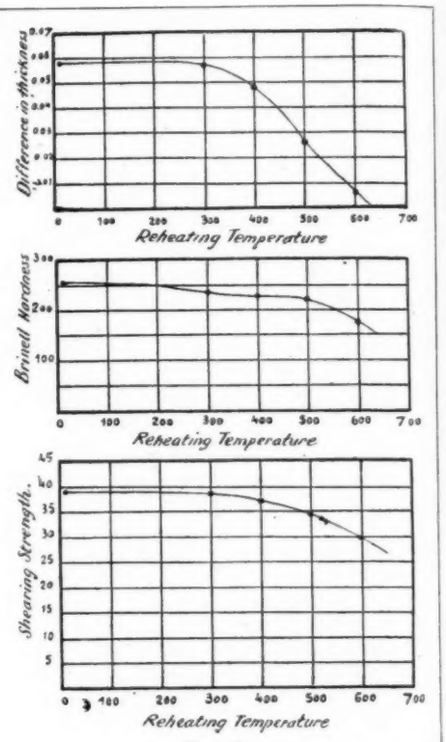


Fig. 2.

After casting, the test pieces were stripped and ground externally along two planes parallel to the transverse plane of symmetry and equidistant from it, the interval between the two planes thus obtained being measured. The thick part of the test piece was then sawn. The test piece was slightly opened by the action of the stresses, and the new interval was measured. The difference between the two measurements was an index of the extent of the stresses existing in the thinned part.

Table I shows the results obtained on rough-cast test pieces reheated to different temperatures, with the corresponding shearing test values and Brinell hardnesses. The reheating lasted six hours, after one hour in raising the test pieces to temperature, with a cooling period of four hours to avoid the formation of fresh stresses. It was found that the effect of the reheating on the stresses began to be perceptible only at about 300 deg. C., and that the stresses practically disappeared at 600 deg. To eliminate these stresses, therefore, it was sufficient to reheat the castings slowly to about 650 deg. C., and then let them cool again slowly.

The strength of the metal was naturally reduced by this treatment (Fig. 2). The structural transformations had been examined micrographically. Up to 500 deg. C. there was no perceptible change apart from a tendency of the pearlite to coalesce. But at 600 deg. C. free ferrite was formed with the deposit of annealing graphite. It should be observed that after casting the stresses were largely localised on the surface of the casting. A rim not subjected to reheating and the exterior of which had been slightly ground under running water, as is done in removing flushes, opened up after sawing only one-third as much as a similar rim in the as-cast condition.

Number of test piece.	State of test piece.	Thickness.		Difference in thickness.	Shearing strength.	Brinell hardness.
		Before sawing.	After sawing.			
		mm.	mm.			
1	As cast	54.142	54.200	0.058	39.25	255
2	Reheated to 300 deg. C. ..	55.045	55.102	0.057	38.70	235
3	,, 400 deg. C. ..	54.946	54.994	0.048	37.10	228
4	,, 500 deg. C. ..	55.000	55.026	0.026	34.40	220
5	,, 600 deg. C. ..	54.972	54.978	0.006	29.90	178

Responsibility Incurred by the Founder in Regard to Stresses Causing an Apparently Spontaneous Rupture.

Nearly all castings were subject to stresses, and in practically every case, except when they were used in apparatus subject to very heavy loads (turbines, Diesel engines, etc.), present-day commercial conditions precluded the loss of time and expense involved in the normalising treatment. The fact must not be ignored, therefore, that foundries were constantly supplying castings more or less subject to the results, sometimes surprising and frequently tardy, of internal stresses. How far, then, did their responsibility extend? His question must not be evaded under the pretext that it did not arise often. Here he was not alluding to trifling incidents affecting small castings weighing a few kilogrammes, which might "crack" in the cleaning or machining. Much more serious cases were not uncommon, and they

* A Paper presented to the Foundry Congress, 1928. The Author is Director of the Plat Foundries, Soissons (Aisne).
† In particular a collection of very fine micrographs.

meant a very considerable financial responsibility.

One of his colleagues had written to him a few months ago as follows:—

"A cast-iron surface plate measuring 2.5 by 1.52 metres, and weighing 1 ton was cast at X, transported to Y by rail, carted to a warehouse, collected, and then taken to a shop with a planing machine large enough to machine it.

"When the work was finished the surface plate was put on a couple of pulleys to load it on to a lorry. Having been lifted horizontally with two chains, it had reached a height of about 1.5 metres to enable the lorry to get below it.

"Suddenly, and before the lorry could get beneath it, the surface plate broke along a line the radii. This casting, strickled and cast with a veritable maze of cores, weighed about 5 tons gross as cleaned.

It had been moulded and cast under definitely correct conditions, and then stripped a week after casting. It was about to be de-cored and cleaned when it cracked over a large surface with a noise like a small explosion. The fracture showed a gap of several millimetres. As his customer assured him that castings identical in every respect had been produced and had turned out well (although this was not strictly accurate), and as questions relating to internal stresses were still difficult to solve, he had agreed to have the casting remade. Let those blame him who had good

Stress in Materials.

There was a large gathering of members at a meeting of the Derby Society of Engineers, held at the Technical College, to hear Professor E. G. Coker lecture on "The Use of Photo-elasticity in Engineering."

PROFESSOR COKER said photo-elasticity was used for experimental purposes for determining the stress and strain in elastic bodies, such as steel, iron, wrought iron and other metals. By the aid of a number of lantern slides actual photographs in photo-elasticity were exhibited. These showed that, under the varying pressures, materials were photographed in correspondingly varying colours.

A Symposium on Steel Castings.

See pages 357 to 359.

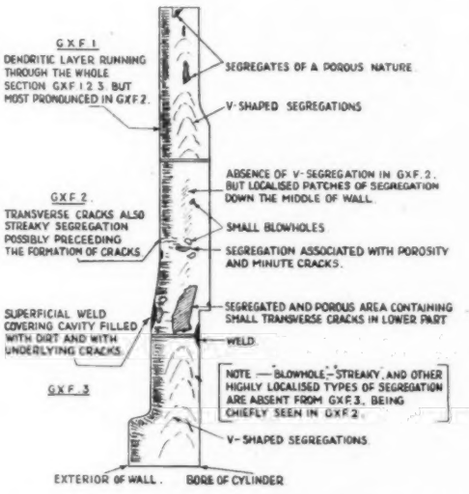

GXF 1
DENDRITIC LAYER RUNNING THROUGH THE WHOLE SECTION GXF 1 2 3 BUT MOST PRONOUNCED IN GXF 2.
SEGREGATES OF A POROUS NATURE
V-SHAPED SEGREGATIONS
GXF 2.
TRANSVERSE CRACKS ALSO STREAKY SEGREGATION POSSIBLY PRECEEDING THE FORMATION OF CRACKS
ABSENCE OF V-SEGREGATION IN GXF 2. BUT LOCALISED PATCHES OF SEGREGATION DOWN THE MIDDLE OF WALL.
SMALL BLOWHOLES
SEGREGATION ASSOCIATED WITH POROSITY AND MINUTE CRACKS.
SUPERFICIAL WELD COVERING CAVITY FILLED WITH DIRT AND WITH UNDERLYING CRACKS.
SEGREGATED AND POROUS AREA CONTAINING SMALL TRANSVERSE CRACKS IN LOWER PART
WELD.
GXF 3
NOTE — BLOWHOLE-STREAKY, AND OTHER HIGHLY LOCALISED TYPES OF SEGREGATION ARE ABSENT FROM GXF 3, BEING CHIEFLY SEEN IN GXF 2.
V-SHAPED SEGREGATIONS
EXTERIOR OF WALL.
BORE OF CYLINDER

Fig. 1.—Drawing of cross-section of large cast steel cylinder showing cavity covered by weld.

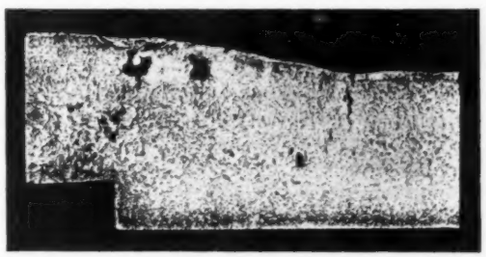


Fig. 2.—Macrograph of the casting shown in Fig. 1. Showing another section through the same weld.

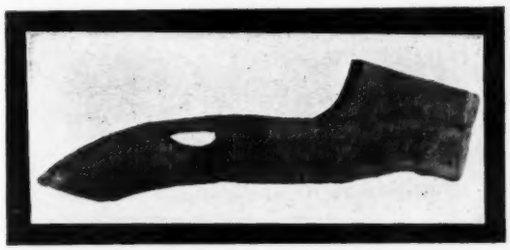


Fig. 3.—Example of serious internal defect undetectable by surface inspection.

Fig. 4.—An X-ray photograph of Fig. 3.

(Illustrations by courtesy of Commander Sidgewick, R.N.)

Fig. 5.—Example of need of co-operation between designer and founder.

which appeared to have no direct relation to the design of the casting.

"The witnesses examined all stated that not the slightest shock took place. An examination of the grain of the casting revealed neither blow holes nor flaws, and the casting had every appearance of being sound.

"The calculation made to test the strength of the casting showed that the stress during its suspension was less than 0.4 kg. per sq. mm., irrespective of the ribs."

Who was responsible? The founder, the fitter or the designer? The author had recently had to assume responsibility for the results of internal stresses in a case which was much more serious owing to the large amount involved. The foundries under his direction had received an order for a machine-tool casting, circular in shape, and over 3 metres in diameter, and with a projection of a few decimetres at the extremity of one of reasons for thinking him wrong. The second casting, which was produced under such conditions as regards care and accuracy as they could doubtless imagine, cracked in absolutely the same way. The line of the crack, the gap, the time after the removal of the sand, etc., were all the same.

Who, he would ask, was responsible? Was it the founder, who had carried out the moulding in accordance with all the rules of the art, who had poured metal of the proper quality, and who had otherwise acted definitely correctly; or was it the designer (in this case the customer), who had subjected the casting to such powerful stresses as compelled it to crack in a manner which might be called mathematically precise in view of the repetition and identical results of the two experiments. He would be glad if such incidents would lead to a discussion from which a rule of conduct for founders might be derived.

Slight pressure produced a yellow colour, which turned to a deep red as the pressure was increased. Faults in the material are betrayed by black lines. The apparatus for the photography consisted of a source of light passing through a polarising prism. The resultant rays were polarised light, being finally analysed into colours representing stresses. It was a remarkable fact, he said, that highly polished materials withstood pressure better than unpolished ones. The reason was that unpolished materials set up pressure lines, which congregated in the interior of the material and produced a weakness. It was undoubtedly the cause of many disasters. One slide reproduced the lines of stress in an ordinary motor-car crankshaft, and methods of counteracting weaknesses in the rectangular bends. The lecturer said that during the last war hundreds of crankshafts were scrapped before a method of counteracting the weakness was learned.

A Symposium on Steel Castings.—

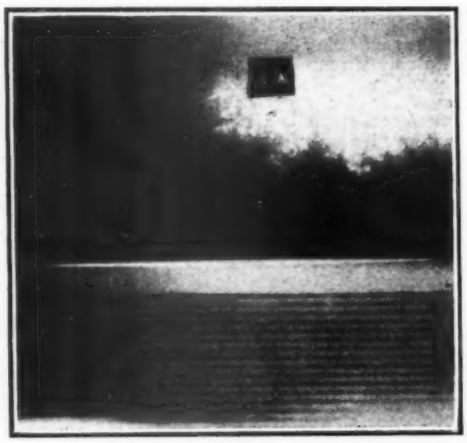


Fig. 1.—Radiograph of iron casting showing porosity.

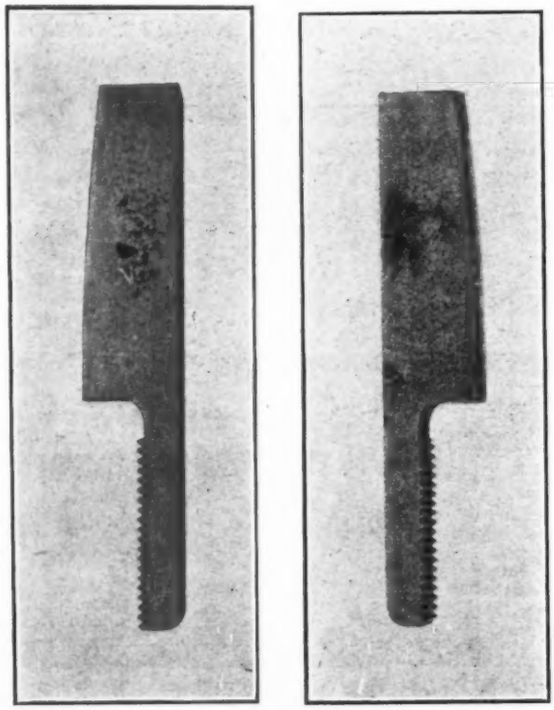


Fig. 2.—Sections of iron casting shown in Fig. 1. The porosity shown by the radiograph was not visible on the surface, but these sections clearly show the fault.

Fig. 3.—Part of a large steel casting showing bad cracks in a blow hole (white). The letters and heavy lines are registration marks.

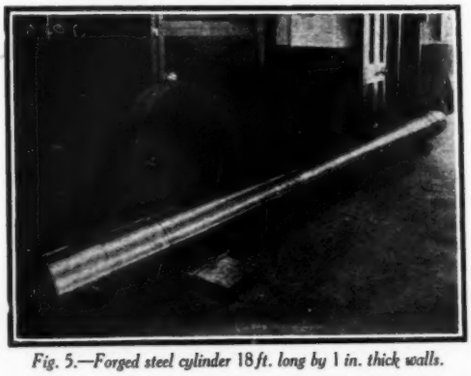


Fig. 5.—Forged steel cylinder 18 ft. long by 1 in. thick walls.

Fig. 9.—Section of lug shown in ... radiograph is clea...

Fig. 7.—Showing tube positi... in these positi... was possible ...

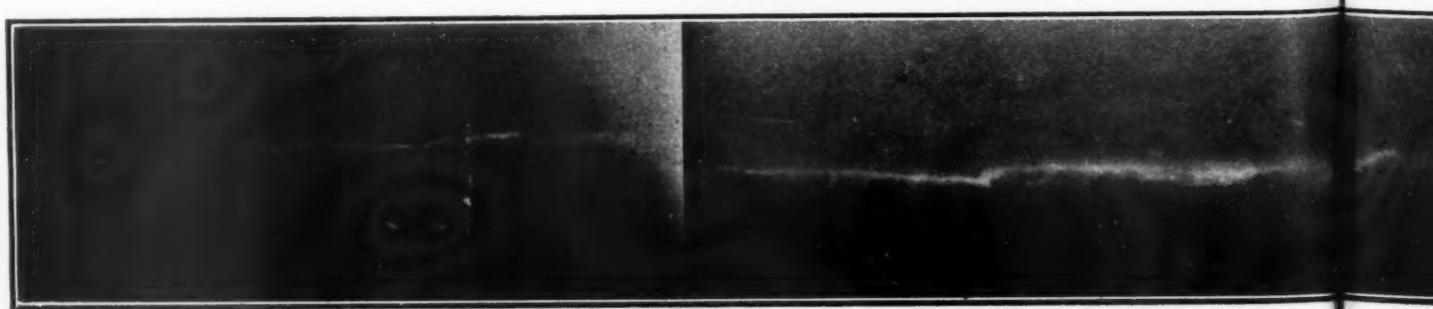
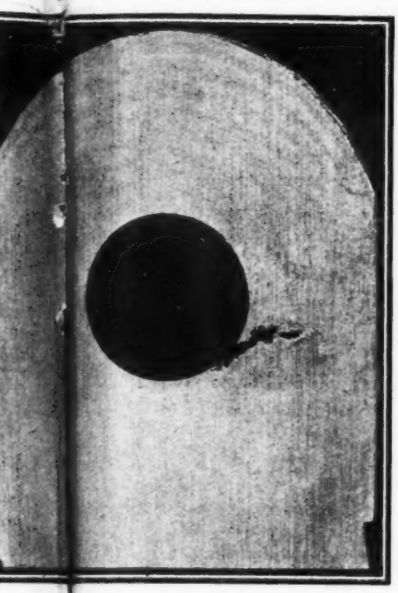
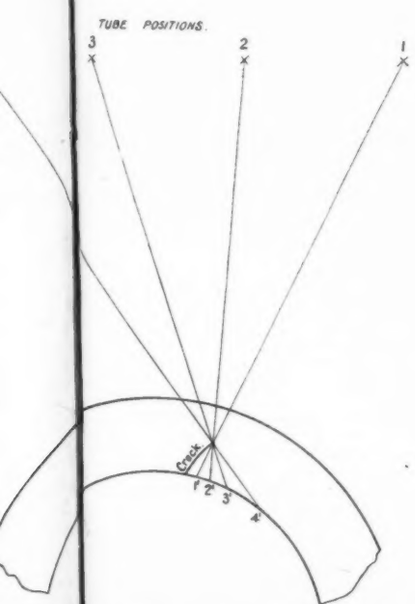


Fig. 6.—Radiograph of forged steel cylinder shown in Fig. 5. The surface marks inside the cylinder were very minute. The X-Ray tube positions are shown in Fig. 7. The break in the radiograph ... a step in the ...

el Castings.—*See pages 357 to 359.* *(Illustrations by courtesy of Dr. Pullin.)*



ig. 9.—Section of lug shown in Fig. 8. The prediction of the radiograph is clearly demonstrated.



7.—Showing tube positions. From the radiographs taken in these positions was possible to indicate the depth of the crack.

e radiograph a step in the barrel thickness of the cylinder.

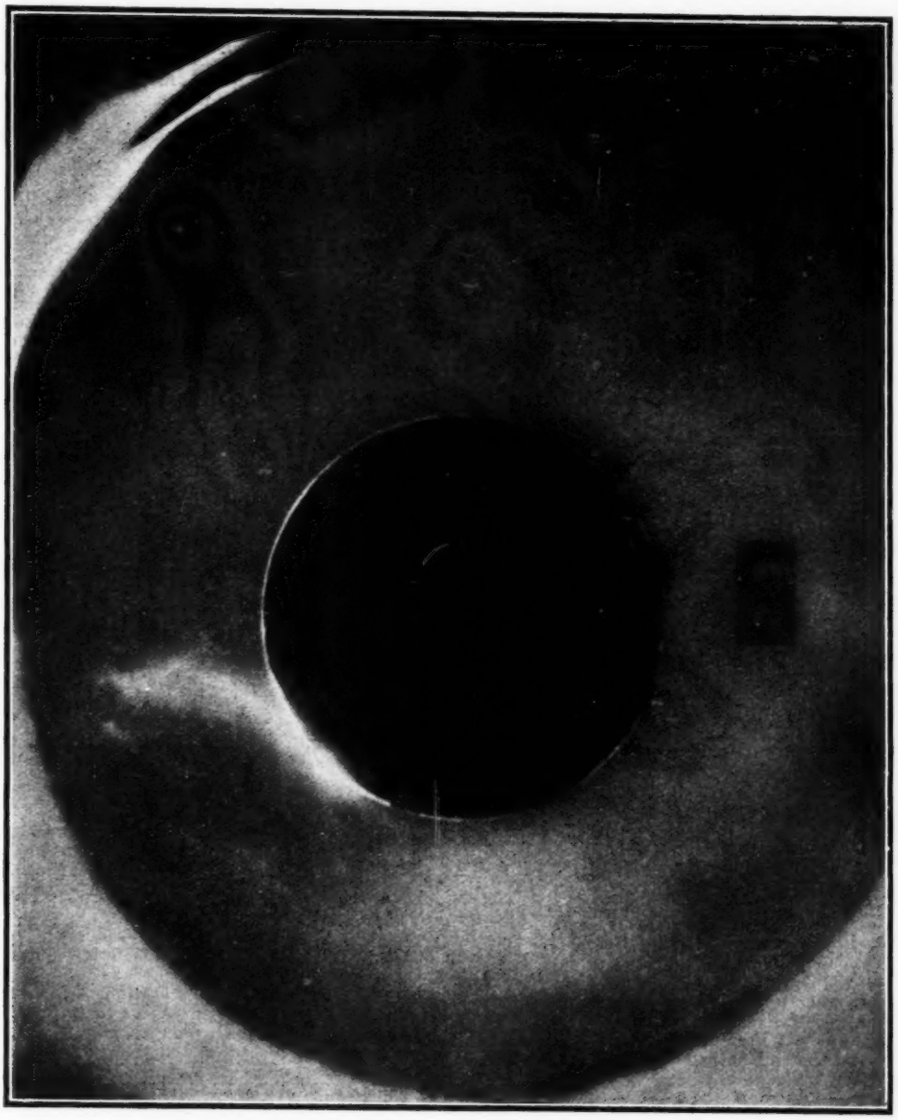


Fig. 8.—Radiograph of a lug of steel casting 2½ in. thick, showing flaws.

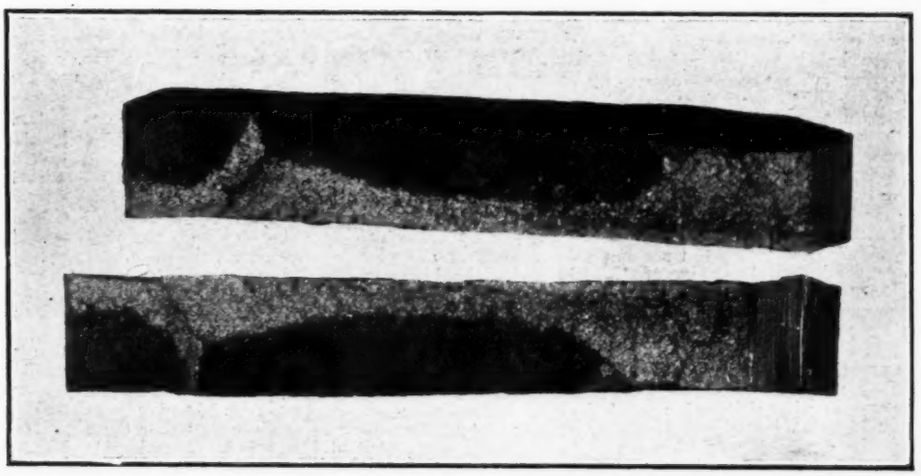


Fig. 4.—Section of fragments of the steel casting shown in Fig. 3. The casting was broken by a hammer and clearly shows the depth of the fault underlying the small surface cracks.

XUM

Foundry Sands.

At the November monthly meeting of the Lancashire Section of the Institute of British Foundrymen, over which Mr. E. Longden presided, Mr. C. Presswood, B.A., of the technical department of the General Refractory Company, Limited, of Sheffield, gave a lecture on foundry sands. The following is a brief abstract of Mr. Presswood's remarks.

Basic Properties.

Mr. Presswood said he had not a wide practical knowledge, he had not been often on his knees making moulds, and he would not dream of telling a company of foundrymen how to get on with their job; but in a way he was familiar with tests which had been applied to sands and ought to be studied. Some people claimed that they indicated a basis upon which foundry sands could be selected and used.

Any sand used for moulding must have three outstanding qualities. It must be capable of great resistance to heat; it must possess strength, cohesion or bond—various names were applied to that quality; lastly, it must have porosity and permeability.

Some people said permeability was very important in the successful use of sands; others—by no means to be neglected—declared that it was relatively unimportant, that other considerations outweighed it. Some who took that view suggested that if an ingot can be cast successfully without any permeability in the container, and if permanent moulds can be used, which are devoid of permeability, then permeability is not so vitally important as it has been claimed to be. His own feeling was that one or two other things accounted for the failure of sands with poor permeability. It had been said if one had the permeability too low, then the casting suffered in consequence, and by reason of blow-holes, scabs and burning on. It should also be said that if the sand was badly graded, and there were coarse particles of sand, together with quantities of silt, thus producing low permeability, bad results would again be had. That was often the result of using spent sand which became ultimately charged with silt. It was possible—although he did not say the argument was full and complete—to argue the other way and say failure in the case of sands of low permeability was probably due to facing the mould with a very fine silt and clay bond which was concentrated in various places—not necessarily because gas cannot get through. It was known that very fine silt is not nearly so refractory as sand particles, and that mixtures of clay and silt are remarkably unworthy of the name of refractories. In many instances if the bond was not free, or if there was a high proportion of silt, it produced a fusible mixture which might give trouble.

Sometimes permeability was regarded as essential because of the gases given off from the metal; all too little attention, he thought, was given to the fact that the mould itself, even if a dry-sand mould, was giving off a quantity of gas (principally) and steam. When coal dust or blacking was used, a certain amount of carbon dioxide was evolved.

Another important point was that all sands, when rammed into position, had porosity apart from permeability; there were porous places, even if one could not blow gas through them. Immediately the hot metal came on the face of the sand the air expanded, and if there were no possibility of that expanding air relieving itself, if it was only just a temporary wave in the face of the sand, there would be a tendency to burst the face, and, as a consequence, produce scabbing and blow-holes.

So there were three factors which suggested that permeability was necessary. He put it in that way because in what followed a good deal of attention would be paid to the permeability of sand and from the figures it would appear to be of vital importance. Therefore he wanted to qualify his remarks to that extent, that he did not think the case for permeability was completely proved as yet.

The first problem which confronted the foundryman was the selection of suitable sand. There were plenty to select from. Foundries were supposed to grow up because sand was found in the locality, and certainly in the case of iron-foundry sands the tendency was to get them locally. Cost was a consideration. Only in the case of very special sand, such as sea sand, or, perhaps, a sand with a strong bond, could the iron foundry afford to pay railway rates to bring it from a long distance.

Limitations of Practical Skill.

Were there any means which would assist the foundryman in his choice? Scientific investigation had gone some way in regard to that problem. Somehow or other any foundryman could tell whether a sand was satisfactory. He had only to pick it up and finger it, and he had a very shrewd idea But the most experienced foundryman would be the readiest to admit there were limitations, and that their judgment might prove to be faulty. In ascertaining whether a sand was suitable, one of the first helps was a chemical analysis. That gave a very fair approximation, in the first place, to the heat-resisting property of the sand. After the chemical test came the refractory test of the sand. That was very useful in the case of fireclay for refractory bricks, but he did not think it was very useful in sands. In moulding sand two ingredients were dealt with—silica grains, which were very refractory, and clay, which gave the bond.

An analysis could be made by attempting to relate the various chemical constituents to the mineral to which they belong. For instance, iron-moulding sand might have as much lime in it as would correspond with 7 per cent. of limestone. Accordingly as to whether the lime was present as limestone or as felspar, so one could begin to criticise or appraise the sand. As a general rule the brass sand need not be so refractory as the sand for iron, and the iron sand need not be so refractory as sand which had to withstand the high temperature of liquid steel.

The difficulty was in adjusting the many factors which could contribute to the success of the sand—the inherent qualities and the treatment which was given afterwards. That applied to the special mixtures which were used for facing as well as to those for packing. So far as the preparation of facing sands went, he thought it was obvious that one could not satisfy all those particular features, yet with certain sands they were gradually moving in that direction. But even though they could not provide the moulder with a complete specification, if he was aware of the way in which various processes—milling, tempering, degree of ramming, and so forth—affected the sand he would probably take more care than was shown in many foundries at the moment. These matters were particularly important in the case of facing sand which impressed its own characteristics on the article which was cast.

Pressure Lowers Fusing Point.

It was generally recognised that for heavy castings a stronger sand was needed which carried considerable bond merely because of the mechanical pressure upon it. A point which had given trouble was that sands which were satisfactory for one metal in small castings, burned on when used with very heavy castings; the difference was that the refractories would not withstand the same heat under the high pressure. Some very interesting tests had been done in that direction—especially on refractory bricks, but also on sand.

A matter for consideration was uniformity in the facing sand mixture. He had observed that beneficial results were got from the uniformity which was made by aerating the sand mixture. It was not sufficient merely to mill. In nine cases out of ten the milling of sand—even under those desirable mills that did not exert considerable pressure and that did not crush the grain—tended to produce a certain amount of packing. Various methods were now available which produced an open, free-venting mixture almost grain by grain without two grains sticking together. It did not lead to the variations in the face of the mould, which were consequent upon a sand which was not so treated.

A good deal of attention was now paid to milling. This was best done in mills which did not crush the grain but which gave an intimate mixture by one grain rubbing against another. The sand was definitely aerated by passing over a rotating conical disc which threw off the sand to the side.

Facing Sands for Non-Ferrous Castings.

As far as he had been able to ascertain, whilst one could more or less specify refractories for steel, when one handled non-ferrous metals there was not very much in the way of assistance from the purely scientific side. At the outset there was the very curious anomaly that whereas in the steel sands they were confronted with considerable temperature, say, 1,600 deg. C., yet lead, which probably cast at about 900 deg. C., would burn on or at least give a burning effect on a refractory sand which could be used for casting even manganese steel. As far as he was aware that had not been completely explained. It was described as a searching effect, and it characterised most of the non-ferrous metals and alloys; which was probably due to the fact that they were "thinner," that is, less viscous on an average.

One outstanding suggestion was that a finer-grained sand must be used, but it had limitations on that account. There was a fair amount of gas in non-ferrous castings, and the ramming must be as hard as possible.

Take the case of aluminium, which was proving a sore point to many people. It had been suggested to him the only way in which aluminium would be cast was by using the minimum of moisture possible, in which case green sand casting could be carried out. Because of the rapidity of cooling, characteristic of that metal, chilling was necessary in all the thick parts.

Effect of Organic Matter on Sand.

A point which had interested him recently was the effect of organic matter, such as coal or blacking, in sand. It was often argued that coal-dust operated because it opened up the sand; it burnt out and left it more permeable and gas could get away. At the same time the burning itself produced a considerable amount of gas and steam. Probably the most reasonable explanation was that the film of gas and steam lay in between the sand and the metal and it gave that peculiar spheroidal effect which was commonly observed when water was dropped on a hot iron. If so, it was conceivable that in many cases gas in between the metal and the sand was responsible for half the beneficial results. He had found a good quality of steel sand which was satisfactory for all ordinary purposes in steel castings failed completely when making small castings of alloy steel, the particular nature of which was not divulged. It was supposed to be a steel cast very hot, and it gave much trouble. The steel was not satisfactory. It was quite a surprise to him to find that a sand which in analysis was little better than a common iron moulding sand satisfied the requirements.

A certain amount of success had been achieved by the use of what was apparently an unsatisfactory sand. It would seem that part of the success was due to the fact that sand bonded with clay and organic material contained an appreciable and expensive amount of coal dust. So in such a problem it seemed as though coal dust and organic material which was producing gas on the face of the mould had helped to solve the problem.

In foundry practice the greatest care should be taken in the preparation and selection of sand. Particularly he emphasised cleaning floor sand. If the floor sand was clean a far greater proportion could be used. He suggested that the idea of counterbalancing the effects of milling by using coal dust was a fallacy likely to be expensive.

Moulding was not an exact science but an art. The moulder was accustomed to use his own judgment in his work, and the application of science to it had been rather bewildering. One could specify a particular analysis, a particular grain size, a particular milling diameter, a certain bond

strength, a particular figure for permeability, a certain degree of ramming, so much drying, accurately controlled conditions. He would then get a certain result. But after specifying sand in that way one might fail absolutely. So there was quite a lot of room for art.

DISCUSSION.

The CHAIRMAN (Mr. E. Longden) said there was much controversy and difference of opinion about the effects of the various elements which go to make up cast iron. In the metallurgical field there had not been a great advance in the technical knowledge of cast iron. Conclusions were, as yet, unreliable. When they began to learn a little more of the composition of sands he hoped there would be less of the extreme clashing of opinion and contradiction which had characterised the study of cast iron up to now.

MR. MASTERS said the lecture dealt with a subject which was one of the most fruitful causes of trouble in foundries whether steel, iron, or non-ferrous. Within the last twelve months more research work had been done on sands by that he meant the raw materials as they came to the foundry—than had ever been attempted before, and foundrymen generally had begun to realise the value of selecting suitable sands—the effect that they had upon the foundry product.

Mr. Presswood had emphasised a point which he thought was beyond all doubt—that the heavy milling of sand was definitely disastrous, and that permeability was really the main factor.

Mr. Presswood had said all moulders were craftsmen. That did not altogether meet the case for the foundryman, because in many places where quantity production was the rule one had to employ semi-skilled labour, and it was essential that every bit of material intended for that class of labour must be properly prepared. Otherwise the semi-skilled men would not make the best use of it.

Quite recently he had the pleasure of visiting a large aluminium foundry. They were casting in green sand, utilising a perfectly aerated sand, and he believed the permeability figure was very high. They faced their moulds with a mixture of oil and another commodity, which was spread by compressed air and allowed to dry, which helped to produce really good castings. He moved a vote of thanks to Mr. Presswood for his lecture.

Gas Content of Sand.

MR. E. FLOWER, in seconding the vote of thanks, remarked that they often heard about facing sand, and the more they heard the more they were impressed with the idea that they had much to learn about the subject. Could Mr. Presswood tell them what was the gas-holding capacity of a given quantity of any sand, especially after it had been dried. He had never heard this phase of the subject touched upon by any previous lecturer.

The vote of thanks was passed unanimously.

MR. PRESSWOOD replied that he could not say off hand how much air there was inside a cubic inch of sand. One could not specify of a particular sand that it was going to give so much air. It depended upon whether it had been aerated or thrown much about in the quarry.

There was a difference between porosity and permeability. The silt called diatoms, which consisted of microscopically small shells, would float in water, yet it was practically impermeable. One could not blow through it. On the other hand, it had been shown that it was possible to extinguish a candle by blowing through an ordinary fire-brick. The brick had permeability. In the case of sand they had permeability because gas could go right through it, but it was also porous, because there were a quantity of spaces which were practically closed in but which contained air.

Air when heated on the face of the mould had to expand. If the mould was also permeable the gas expanding at high temperatures would burst from its confinement.

If anyone wished to determine that problem the method to follow was to cut a piece of the rammed sand and get to know its exact weight—say one cubic inch. Dry that, and the moment it was sufficiently hard, immerse it in water, and allow the water to sink into all the porous places. In that way one could measure the amount of air.

Permeability and Porosity.

MR. S. G. SMITH said this was the first time he had heard of coal dust being used for a facing sand with steel. In his opinion Mr. Presswood had not given a correct definition of the function of coal dust in facing sands, particularly with reference to iron castings. It was not put in to give permeability or porosity or anything else, but for this purpose. The moment the iron came in contact with it, a gas of a tarry nature was evolved and deposited on the walls of the moulds as the metal rose—a thin film of carbon, or soot, which protected the weak, fusible silicates in the sand. It was of a refractory nature, and gave a clean skin. That was his own definition of the action and function of coal dust, but he did not know how far others would agree with it.

Mr. Flower had raised a very interesting question—the amount of air contained in a given area of sand, but a still more important factor was that even when casting at an ordinary temperature, 1,400 deg. C., whatever the amount of the air in a given area was, it was increased in volume five times. The moulder and the core maker had to make provision to evacuate that air quickly when pouring a casting. The condition was intensified when dealing with moisture. Very bad accidents had happened in foundries from excessive moisture. There was an expansion of 1,728 times, that is, from water to steam.

Many years ago he put together certain compositions of sands, classified by himself as weak, medium and strong. He was endeavouring to see whether it was possible to get some guide to the different classes of sands to be used for various castings. He believed it worked out, roughly, that weak sand was suitable for weak, small castings; medium sand was suitable for medium-sized castings; and strong sand had to be used for heavy castings. He worked that out roughly with three lots of red sands and three lots of yellow sands. Strong, medium, and weak were based on clay content, not fusion test.

There were various shades of red sands and various shades of yellow sands. The yellow sands were not so well known in the Manchester district as they were further north, *i.e.*, on Tyne, Tees and Wear. As far as he could see, the colour partly depended upon the presence of iron oxide in the red sands and upon the presence of aluminium oxide in the yellow sands. Could Mr. Presswood say exactly what determines the various colours of foundry moulding sands?

He was glad Mr. Presswood had emphasised the question of permeability when an object or aggregation was permeable it was porous; yet material could be porous without being permeable. What was required was that air should pass through.

The lecturer also referred to permanent moulds which were practically impermeable, yet one had no gas trouble with them. But the foundryman who had to use sand and other similar material for making his moulds must consider permeability.

The effect of hard ramming in making dense sand had been mentioned. With very thick castings one had to ram hard to prevent them from swelling. One way to overcome the difficulty with the density was the free use of a venting wire.

He was surprised to hear Mr. Presswood say that lead would eat into a highly refractory sand. That was a problem which might be explained some time in the future, but so far it had not been thoroughly explained. Many years ago, when a young lad, a big lead pan was made which weighed some tons, and its mould was not vented at all. The sand was rammed very hard and no vent wires were put in—why, he did not know, but he supposed, at that distant time, it was on account of the peculiarity of the metal and the way it lay easily on the hard-rammed surface. They had no eating into the skin, the lead pan was quite clean. They were using an ordinary medium bonding sand at that time.

MR. PRESSWOOD said he was absolutely certain of the fact that in a steelworks coal dust was used in the facing mixture. He was very glad that Mr. Smith supported the suggestion that permeability was important, not merely to evacuate the gas from the metal, but also because the air in the sand expanded. He had been trying to put both points of view because the subject interested him.

Iron oxide was certainly the principal colouring agent in all sands. The strong preference for red sands shown by many people was due to the fact that they preferred a sand which was bonded by iron oxide. That was particularly so in the case of steel sands. He knew there was a strong preference for yellow sands in the Pontefract district.

Bunter Sands.

The very strong feeling in favour of the red Bunter sands, whether the users knew it or not, certainly arose from the fact that those sands were bonded with ferrous oxide forming an iron-oxide bond. In those sands it was present in the colloidal or sticky hydrated form, giving a very effective bond which was not easily destroyed. There were sands of yellow colour which contained quite as much iron oxide as the red sands. They did not show colour to the same extent because, in the first place, it might be modified by lime, secondly, the iron oxide might be present in those sands as siderite $FeCO_3$ or carbonate of iron. That was quite common. The ferrous oxide imparted very little colour, if any, to the mineral which contained it. Instead of being of a typical rusty-iron colour the sands were greyish in colour. That was due to the presence of the ferrous oxide. Occasionally one came across a yellow or greyish moulding sand which contained an appreciable amount of iron oxide.

Aluminium did not impart any colour to sand; it was usually present as a clayey substance, silica of alumina, with water forming a sticky clay which was colourless. Generally the only colour that clay had was imparted by iron oxide. Sand which was merely bonded by pure clay, like china clay, would be hopelessly unsatisfactory, and it would have practically no colour at all.

Mr. Smith had stated that where heavy ramming had been necessary to prevent swelling, so venting was resorted to. He (Mr. Presswood) did not know whether he was right in suggesting that, after all, venting did compensate for lack of permeability. Permeability was destroyed by ramming, but was increased artificially by venting.

Machine-Moulded Castings Deemed to be Harder.

MR. A. JACKSON said one of the difficulties in a lecture of this kind was that the foundryman wanted to get from the theoretical stage to something practical which he could apply in everyday practice. Perhaps the lecturer could enlighten them upon two or three points which appealed to himself as a practical man.

Red sand very often arrived with a quantity of white pebbles in it, and they might be having trouble somewhere as regards the facings. The question arose: Were those pebbles seriously detrimental, and was it advisable to get rid of them by riddling the sand, which would add considerably to the cost?

After milling sand was it helpful to let that sand stay over a day or two before sending it to the moulder for use? His own opinion was that there was an advantage in the delay; the water and other constituents were more evenly distributed through the heap, so that the sand was in better condition for use, after a day or two, than if it had been sent to the moulder at once.

A planing and milling machine hand put to him this question: "Why is it that the castings which come from the hand moulder are softer than the castings which come from the machine moulder?" He replied that the difference arose from the fact that the loose-pattern moulder was more careful in his distribution of the facing sand. Generally such facing sand had coal dust in it, and the air on the surface of the mould was substantially warmer. The machine moulder generally took a more lenient view of the fact that the moulds had to be faced and his facing sand was not evenly distributed. Generally he thought coal dust had a helpful effect on the face of the mould.

MR. PRESSWOOD said a foundryman who received sand with pebbles in it was entitled to complain. Red sand was associated with the Bunter beds; near the Bunter sands were widespread pebble beds which were the source of perhaps 50

per cent. of the concrete made in this country. It was very rarely that large faces of sand free from those pebbles could be guaranteed. A study of the conditions which obtained when the sands were laid down indicated that at the same time pebbles were accumulating side by side with them. Sometimes there were pebbles underneath the sand. In the quarries, the overlay often contained not merely pebbles but angular stones, maybe limestone. So the supplier had his own difficulties. There were, however, large quantities of quarry faces quite free from pebbles.

Difficulties in Quarrying.

To insist upon always being provided with sand that contained not a solitary particle of clay or foreign stone, or anything of that kind, would increase the cost at the quarry, though, of course, that might yield a lower figure than what it would cost the foundry to eliminate them. He certainly thought pebbles ought to be cleaned out before using the sand. Since they occurred in red sand they were probably all quartz or silicious rock and would affect the face of the mould, causing many types of trouble. For instance, they might be responsible for quite a serious blemish on the face of the casting. Limestone, too, was particularly objectionable.

In one steel foundry trouble was experienced with sand, and a man was detailed to investigate. He observed that there were considerable particles of coal in pellets of unused sand. He ascertained that the trucks in which that sand was delivered had previously been used for transporting coal, and particles of coal were being included in the sand. He secured clean trucks, and utilised a really clean sand free from coal dust, and there was no more trouble with the castings. Not being content with that he added coarse particles to the sand, and the trouble was reproduced. Thus, he produced both positive and negative proof that the coarse particles of coal dust were the cause of serious trouble.

The gaseous matter given off by coal dust certainly proved somewhat beneficial. He did not mention tarry liquid because he thought the matter evolved from the coal dust was of a gaseous nature rather than liquid or solid. Even tar would burn under the heat conditions of the mould.

In some cases sand deposits resembled rock which was pulverised and sent out in a disintegrated condition. It was not necessarily screened. A difficulty in regard to screening sand was that the ideal particle might be only a 32nd of an inch in size, and to screen everything above a 32nd of an inch would be very expensive.

Weathering Moulding Sand.

He was glad Mr. Jackson referred to the beneficial effects of allowing sand to stand over for a few days. He had had to deal with a parallel problem in brick-making. Bricks were made from material which was comparable to moulding sand, and it was found that very beneficial results were obtained if the raw material was allowed to stand over—they called it souring. It was due, as Mr. Jackson suggested, to the more even distribution of water throughout the heap and also to the fact that in milling a fair amount of heat was generated. Excessive milling in a fairly strong-bond sand nearly always produced heat, and warm, steaming sand was not as satisfactory as a sand which was at an even temperature.

The question about the difference between the castings produced by the hand moulder and those produced by the machine moulder was difficult. He took it that there might be a difference in machining because sand on the face of the casting had a chilling effect. If that difference was established it was probably due to excessive chilling in one case, but his ideas were somewhat nebulous in regard to the matter. It might be argued that the mould face produced for the hand moulder happened to be warmer than that which was produced for the machine pattern moulder, but he did not see much reason for that. It looked like a chilling effect which he could not explain. He should not think it was general, but it might occur in one particular case dealing with a particular sand.

Expansion of Cores.

The Chairman said during the last two years he had been taken to task for suggesting that silica grains did expand and contract. He had asked whether it was possible for a core, after being subjected to the drying temperature in the stove to be of the same size after drying as before. His claim had been that the core expanded, except, perhaps, when using oil sand. It had been in his mind to ask the lecturer whether expansion was due to the action of the binding material or whether it was due to the decomposition and expansion of the gas—if it was not due to the sand expanding and deranging the grains.

Another point was this. In the case of two dry-sand moulds finished similarly with the same amount of blacking upon the face of the moulds they often obtained burning-on of sand, due to one of the moulds not being thoroughly dry. Some action was taking place there, in which, probably, the water vapour was decomposed by the heat of the metal and the oxygen liberated possibly combined with graphite at the ignition temperature, and thereby robbed the mould of its refractory covering. He would like Mr. Presswood to say whether that was so.

Mr. Presswood said this point about expansion in the stove had been put to him, though only on hearsay, by a man who did not profess to have a knowledge of foundry work or of refractory technology. He happened to be present at a lecture when a long discussion took place on the question of expansion of cores. He declared that the expansion which was being considered was the expansion of the core after casting; he suggested that after casting a core expanded so much that it could not be got back into the core box. Certainly the heat of casting was sufficient to cause silica to expand, but he (the lecturer) could not help thinking from the nature of the problem that what the foundrymen present at that lecture were discussing was the expansion of cores in the drying stoves.

Changes at High Temperature.

Ordinary silica was found in nature in the form of quartz. At about 500 deg. C. quartz expanded very definitely. He did not say that accounted for the increase in size as far as these cores were concerned, they were generally only heated to about 220 deg. C There would certainly be a little expansion of the quartz from the alpha quartz to the beta quartz, but on cooling it returned to the original state. At 575 deg. C. beta quartz was the stable form; below 575 deg. C. alpha quartz was the stable form. If any change took place in the nature of the quartz through heating it would come back again when cooled. So to his mind drying in the stove did not account for the expansion of silica in a core. He did think that changes took place in the drying af a core which might account for it. Clay bond dried at the same temperature as boiling water, but there was still water in chemical combination with the clay. He thought in most core drying they were removing some combined water. So without any definite expansion of the individual silica grains he thought there was a tendency to get a shifting movement, which, in nine cases out of ten, would result in an alteration of the overall dimensions.

He understood the chairman to say that he had contradicted some of his colleagues. That meant, he supposed, that they did not agree that silica expanded.

The Chairman: They say sand does not expand in the drying stove.

Quartz in Facing.

Mr. Presswood said if anybody had made that remark it ought to be qualified. There was no material under the sun which did not expand with heat. Certain qualities of steel commonly used for tramway lines had a very low expansion, and the same could be said about some materials used for refractories. But practically speaking, he knew of nothing which had no expansion with heat. Quartz showed its first expansion at 575 degrees C. When it reached the temperature of molten iron or steel there was a strong tendency for quartz to take another form. Anybody who had made bricks knew that mica bricks had considerable expansion, permanent expansion. He did not think there was the slightest doubt that when there was a skin which one could pull off the face of the casting it could be proved that the quartz had undergone a change and was present in a different form. A fairly considerable formation of silt in spent sand was supposed to be due to the splitting of quartz particles.

Might not the trouble with the two moulds to which the Chairman had referred be explained by the supposition that an excess of steam had resulted in a bursting of the skin? There was a tendency for a skin to be formed on the mould before it was actually filled, and that skin might be less permeable than in the case of an ordinary green sand or ordinary dry sand mould. Steam or gas would burst that skin and be responsible for a defective casting.

Fool-Proof Raw Materials.

Mr. A. Sutcliffe said neither the blast-furnace owners nor the quarry owners guaranteed the results obtained in practice; the foreman moulder had to shoulder the results of the castings he received from his men. Why did not the pig and sand suppliers deliver their goods fool-proof, in the same way that the foundryman was expected to deliver a good casting?

In his opinion, Mr. Smith was right in stating that the action of the coal dust was to form a film of gas between the sand and the metal. The vent wire was a good thing for getting the air away where the sand was rammed hard, because it allowed of quicker action, and prevented the sand from scabbing and the mould from blowing.

If sea sand was milled dry in an ordinary mortar mill, would it crush the sand grains in any way and make the sand much finer?

He agreed with Mr. Jackson that the sand would be in better condition if allowed to stand for some time. On that point he would refer to his experience in casting 10 ft. square open sand loam plates, weighing about 4 tons. One in the morning and another in the afternoon would yield quite different results, which indicated that the more time the sand had to settle, the fewer the scabs on the casting.

Mr. Jackson had referred to castings being hard. Did Mr. Jackson's machine moulders knock those castings from the boxes just after casting? Not many jobbing moulders knocked out their castings from the boxes until the following day, and if this was the procedure followed, then it would account for the castings being harder to machine. Moreover, there was not so much machinery allowance on a machine-moulded casting, and therefore the tool was always cutting on the surface.

An Experiment with Cores.

Mr. S. G. Smith described an experiment in drying three cores made from sand which he had selected; one utilised weak sand, one medium sand, and one strong sand. The temperature in the stove was as nearly as possible the same in each case. They were put in the stove at night and he examined them in the morning. Under the calipers one, the weak sand, was found to be slightly below the size it was when put in; one, the medium sand, was exactly the same, and one, the strong sand, had slightly expanded. That simple experiment helped him to solve the problem he was considering at the time. It proved, as was suspected, to be an expansion of strong clay sand which had caused trouble.

In large circular castings, 3 to 4 ft. in dia., sometimes the inside was badly marked in a puzzling manner. Sometimes they went up in bricked cores 7 to 8 ft. in dia. Some cores were made on iron barrels, carrying no hayband or bands. The loam was laid on to the barrel when hot or warm. When it was dried, it was struck up in the ordinary way with fine loam. The cores were struck up in the ordinary way, and when the castings were stripped they were often very marked inside. He did not attribute that directly to expansion of the cores. In his opinion, what happened in that case was that the barrel expanded during the drying. At the time the mould was cast, the barrel was cold, and its contraction left a slight space between the barrel and the loam, and when the pressure of the metal became severe it forced the loam towards the iron barrel, forming many marks, resembling map lines.

XUM

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PIG
IRON
THE STANTON
IRONWORKS
COMPANY LIMITED
NEAR
NOTTINGHAM

Trade Talk.

CABLES FROM NEW YORK state that the opening of the new United States National Metal Exchange was fixed for Monday last, December 3.

MESSRS. VICKERS-ARMSTRONGS, LIMITED, have received from Messrs. Lever Bros., Limited, an order for two pairs of steel lock gates for their new dock at Bromborough.

THE FOUNDRY and engineering plant of Messrs. Cole, Marchant & Morley, Limited, Wakefield Road, Bradford, is to be sold by auction in January. The firm was founded in 1848.

IMPORTS OF IRON ORE at Newport during October totalled 68,347 tons, while 40,420 tons were discharged at Cardiff, and 13,413 tons at Port Talbot. Of the total imports, 68,641 tons came from Spain.

APPLICATIONS FOR THE DISCHARGE from bankruptcy of Mr. H. H. Roberts and Mr. B. D. Roberts, iron-founders, of Deanshanger, Stony Stratford, will be heard at the County Hall, Northampton, on January 8.

THE HASLAM FOUNDRY, of City Road, Derby, have recently completed some big castings for the Derby Corporation Electricity Department, and the task of placing these in position at the electricity station is being carried out.

MESSRS. PALMERS SHIPBUILDING AND IRON COMPANY, LIMITED, Jarrow-on-Tyne, have booked an order for a motorship of 12,000 tons for the Blue Star Line. Another contract received by the firm represents several months' repair work on an Ellerman liner which was damaged in a collision.

THE NEGOTIATIONS commenced some months ago by the Harriman group concerning the purchase of Königshütte and Laurahütte, the former German iron-works that passed into the possession of Poland, are making favourable progress. A holding company is to be formed with a capital of $15,000,000, and a portion of the Preference shares is to be applied to buying up the majority of the Laurahütte shares which are now in German hands.

EXTENSIONS ARE TO BE MADE at the Coombs Wood Tube Works, Halesowen, of Messrs. Stewarts & Lloyds, Limited. Contracts have been placed with a Manchester firm for the erection of engineering work-shops which are to cover an area of approximately two acres. An official at the Coombs Wood Works stated that the buildings would be utilised for the manufacture of tubes by a new process. Two years will be taken to complete the work of erection.

THE TWIN-SCREW tug and salvage vessel, "Sir William Hoy," built by Messrs. Sir W. G. Armstrong, Whitworth & Company, Limited, for the South African Railways and Harbour Administration, was launched from the Tyne Iron Shipyard, Willington Quay-on-Tyne, on Nov. 28. She is the most powerful vessel of her type that has been built, and is fitted with a twin-screw installation of triple-expansion engines capable of developing together 3,500 i.h.p.

MESSRS. CHRISTMAS & WALTERS, LIMITED, the suppliers of the well-known R. D. Wood gas machine, have just received an order from Messrs. Taylor Bros. & Company, Limited, of Manchester, who already have twice installed these machines, for further plant. This latest order will cover numerous improvements recently made in the R. D. Wood gas machine, which greatly increase its flexibility as regards the amount of coal gasified per hour, and also reduce the cost of the gas machine and of the installation.

IMPORTERS OF IRON ORE in Glasgow decided at a meeting held on November 28 to intimate to the Trustees of the Clyde Navigation that they are opposed to their proposals to obtain powers which provide that the work of stevedoring at Rothesay Dock (at which practically all cargoes of iron ore arriving at Glasgow Harbour are discharged) may be carried out only by persons employed by the Trustees. Importers are apprehensive that the use of the employés of the Trust for this work would result in an increase in charges and necessitate an addition to prices of iron ore.

New Companies.

G. F. Taylor (Brass Founders), Limited.—Capital £1,000. Director: G. F. Taylor, 97, Welholme Road, Grimsby.

Grinding, Limited, 10, Vauxhall Street, Birmingham. —Capital £6,000. Grinders, groovers, and polishers of metal rolls, etc. Director: C. Higgott.

William Campbell & Company (Iron Merchants), Limited, 394, Paisley Road, Glasgow, C.5.—Capital £6,000. Directors: W. Campbell, H. Campbell and J. Wilson.

Company Meetings.

Sheffield Steel Products, Limited.—The annual meeting was held on November 27, at Sheffield, MR. C. P. JOHNSON (chairman) presiding. The chairman said that the accounts showed a substantial improvement in the position of the company. There was a trading profit for the year of £35,011, an improvement of £44,780. Conditions remained difficult, but, notwithstanding this, the estimated results for the first five months of the current financial year showed a satisfactory improvement over those of the corresponding period of last year. They had adopted a policy of endeavouring to strengthen their structure by securing new lines for manufacture capable of yielding a substantial profit. They had already made good progress in this direction, and had obtained manufacturing rights for new lines which they believed would be of considerable value.

South Durham Steel & Iron Company, Limited.—An extraordinary general meeting of the shareholders of the South Durham Steel & Iron Company, Limited, was held at West Hartlepool, on Nov. 28, for the purpose of sanctioning an increase in the capital of the company and of approving the scheme of amalgamation of interests with the Cargo Fleet Iron Company, Limited. MR. BENJAMIN TALBOT (deputy chairman and managing director), who presided, said that, in view of the present unfortunate state of the iron and steel industry, the need was realised of suitable amalgamations being effected in order to keep pace with the competitive power of large aggregations of capital which had been brought together on the Continent and elsewhere. There was no doubt that by the elimination of unnecessary competition, and the pooling of resources in manufacture, as well as in buying and selling, important economies could be effected, provided that the basis of amalgamation was sound. The proposals were approved.

Millom & Askam Hematite Iron Company, Limited. —The annual general meeting was held on Nov. 26 at Liverpool. MR. G. MURE RITCHIE (the chairman), who presided, said that the shareholders would derive some comfort from the fact that, with the exception of 1922, the company had made profits through the years of the great slump. Owing, however, to continued depression, to exceedingly severe competition for the small volume of orders, and the low prices for pig-iron and ore, it was impossible to earn substantial profits. One of the reasons why it was impossible was the importation during the year ended September 30 last of 3,119,500 tons of steel and iron into Britain from Continental countries, where wages were lower, hours of work were longer, exchange was favourable, railway rates were lower, and taxation less. Had this huge importation of steel been made in Britain, the cost of production on a larger total output would have been much less, and, while prices to consumers need not necessarily have been raised, there would undoubtedly have been a substantial margin of profit. Other contributing factors to meagre profits were high railway rates and local taxation, the assessment of their Florence Mine having been heavily increased. While the quality of Millom pig-iron was as good as ever, there was not the same demand for it, two special directions in which this was felt being the dwindling manufacture of armoured plate and guns and the diminished production of high-class steam boilers, due to the development of the internal-combustion oil engine. There was also the factor that some steelmakers had acquired control of blast furnaces and took their requirements chiefly from those sources. If, failing safeguarding or expansion of trade, they failed to attain former profits by the manufacture of pig-iron, they had provided a substitute in the form of iron-ore resources. The Alquife Mines had in particular an international and rapidly expanding market for their ore, and they formed one of the company's most valuable assets. Not only the whole of this year's but half the 1929 output was sold for shipment.

Obituary.

THE DEATH has occurred at the age of 60 of Mr. Alfred Wassell, J.P., of Kilburn Hall, managing director of the Denby Iron and Coal Company, which position he had held for the past ten years. The deceased, who was highly respected by the ironworkers in Derby and various parts of Nottinghamshire, where he was well known, had been connected with the Denby Iron and Coal Company for about 30 years, and had rendered a splendid service. He had been a very active man and had been associated with the public life of the county, being a member of the Derbyshire County Council, a Justice of the Peace, and a Freemason.

Contracts Open.

Brixton, Devon, December 21.—Steel and cast-iron water mains, etc., for the Plympton St. Mary Rural District Council. Mr. P. T. Loosemore, clerk, Underwood House, Plympton. (Fee £3 3s., returnable.)

Dundee, December 11.—Iron and steel stores, for the Dundee Harbour Trustees. Mr. J. Hannay-Thompson, Harbour Chambers, Dundee.

Durham, December 13.—Cast-iron pipes, etc., for the Durham County Water Board. Mr. W. R. Ward, clerk, 25, Northgate, Darlington.

London, S.E., December 17.—163 tons of spring steel for the India Store Department, Belvedere Road, Lambeth, S.E.1. (Fee 5s., non-returnable.)

Stoke-on-Trent, December 11.—Provision and laying of cast-iron mains, etc., for the Stoke and Wolstanton Board of Guardians. Mr. T. Wood, clerk, Stoke-on-Trent. (Fee £1, returnable.)

Johannesburg, January 22. — Steel and cast-iron pipes, etc., for the Municipality of Grahamstown. The Department of Overseas Trade. (Reference A.X. 7182.)

Limerick, December 15.—5-ton portable crane, for the Harbour Commissioners. The Harbour Engineer, Engineer's Office, Docks, Limerick.

New Delhi, December 17.—Oil-engine pumping sets, for the Indian Store Department. The Department of Overseas Trade. (Reference A.X. 7141.)

Port Elizabeth, S.A., January 10.—Cast-iron spray cooling equipment, for the Municipality (Specification No. 13). The Department of Overseas Trade. (Reference A.X. 7118.)

Sunbury Common, Middlesex, December 31.—Two centrifugal pumps, etc., for the Metropolitan Water Board. The Chief Engineer, 173, Rosebery Avenue, London, E.C.1. (Fee £1 1s., returnable.)

Sydney, N.S.W., January 2.—Hydraulic pumps, for the New South Wales Government Railways. The Department of Overseas Trade. (Reference A.X. 7150.)

Wellington, N.Z., January 8.—Internal-combustion locomotive, for the Public Works Department. The Department of Overseas Trade. (Reference A.X. 7125.)

Westbury, Wilts., December 8.—Pumping plant, for the Westbury and Dilton Marsh Joint Water Committee. Mr. A. P. I. Cotterell & Son, 54, Victoria Street, Westminster, S.W.1. (Fee £5 5s., returnable.)

Westbury, Wilts., December 8.—Construction of a pumping station and the provision and laying of cast-iron mains, for the Westbury and Dilton Marsh Joint Water Committee. Messrs. A. P. I. Cotterell & Son, 54, Victoria Street, Westminster, S.W.1. (Fee £5 5s., returnable.)

Reports and Dividends.

Platt Brothers & Company, Limited.—No interim dividend on the ordinary shares.

Dorman, Long & Company, Limited.—Profit, £353,207; brought forward, £2,107; debenture interest, £227,669; year's dividend on 6 per cent. cumulative preference shares, £31,083; debenture redemption fund, £39,940; depreciation, £50,000; carried forward, £4,621.

Baldwins, Limited.—It is proposed that the company's financial year shall in future end on December 31. The directors are submitting accounts for the six months ending December 31, 1927, which will enable accounts for the full year, 1928, in which the results of the scheme of arrangement will be incorporated, to be submitted to the next general meeting. The profit and loss account shows a loss (excluding the results of subsidiary companies) of £7,477. Balance brought in from June 30, 1927, was £55,297. Balance forward, £47,820.

Personal.

MR. A. H. MADDOCK, of Messrs. John Maddock & Company, Limited, Oakengates, Shropshire, has changed his address from 116 to 138, Liverpool Street, Southport.

MR. H. J. MAYBURY has resigned his position as metallurgist with Messrs. J. Stone & Company, Limited, of Deptford and Charlton, in order to establish a light alloy foundry business, details of which will be published in our next issue.

MR. E. A. MALLATRATT, one of the best known men in the foundry industry of Notts, has, with his wife, just celebrated their golden wedding. Mr. Mallatratt, who was for many years associated with the Meadow Foundry Company, is now engaged with the firm of Messrs. Wallis & Manners. To commemorate the occasion Mr. and Mrs. Mallatratt, who live at 18, Westfield Lane, Mansfield, have been presented with a handsome clock and easy chair by his colleagues at the works.

XUM

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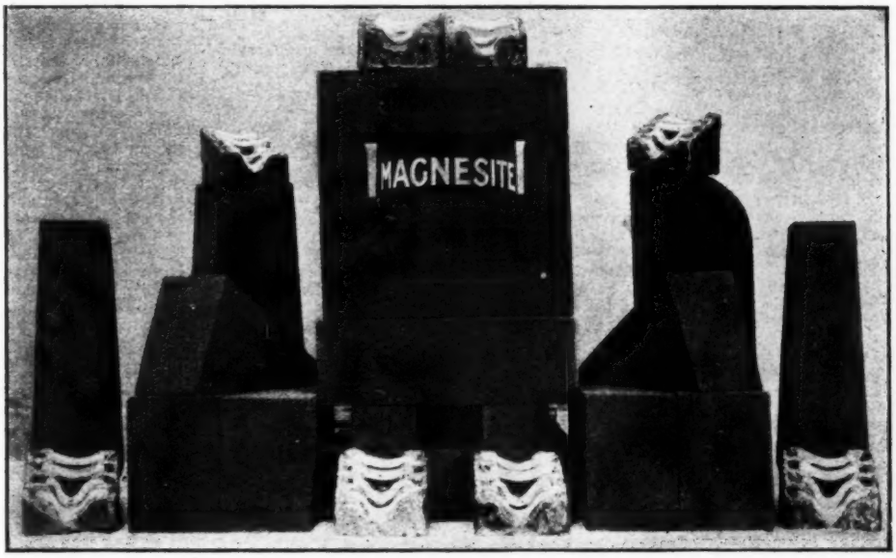
BRITISH MADE MAGNESITE BRICKS, PERFECT IN SHAPE, HIGHLY REFRACTORY, EQUAL IN PRICE



"SERVICE GRC **FIRST"**

—yes, but in this case, usefulness and craftsmanship go hand in hand.

The perfection of shape and regularity of size of our

BRITISH MADE

MAGNESITE BRICKS

are due in large measure to

accurate burning.

The temperature is controlled by Holdcroft's Thermoscope Bars, sets of which are placed in each kiln. The even bending of the bars shown above, and which are taken from several kilns, illustrates the regularity of firing.

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Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—The moderate improvement noted of late in the Cleveland pig-iron trade, though still continued, has so far been insufficient to restore confidence in an early return to anything like normal activity. Market movements are again on a quiet scale, while forward business is very seldom mentioned. The home demand for pig-iron remains unusually quiet from a seasonal point of view. The foundries have not yet benefited by the recent increase in shipbuilding orders, and consequently are limiting buying until the position is more clearly defined. Notwithstanding the ironmasters' affirmations that the benefit to be derived from the railway rebates is less than the actual loss incurred in the production of Cleveland iron, consumers still incline to the view that they should get at least some of the benefit from the reduced cost of manufacture. In the circumstances consumers are still maintaining a policy of reserve in buying, while, as regards export trade, last month's returns of shipments from Tees-side ports are below the average for October. Prices are unchanged. No. 1 Cleveland foundry iron still realising 68s. 6d., No. 3 G.M.B. 66s., No. 4 foundry 65s., and No. 4 forge iron 64s. 6d. per ton, f.o.t. or f.o.b.

The North-East Coast hematite market has experienced a slight setback in export demand since the recent stiffening of prices, but a fair volume of business is passing on home account. The variation of quotations indicates that prices are not very rigid. For small prompt lots, f.o.t. Middlesbrough, 71s. has been realised, but the figure would be broken for a good order, and possibly 70s. would not be refused if a substantial contract were at stake. No. 1 quality is at a premium of 6d. per ton over mixed numbers. On the North-West Coast Bessemer mixed numbers are quoted at 70s. to 70s. 3d. per ton at works.

LANCASHIRE.—As is customary at this period of the year, buying of foundry pig on local consumers' account is invariably restricted, and very few changes in prices may be expected until after the holidays. Meanwhile quotations rule steady, as follow:—Derbyshire No. 3, 68s.; Staffordshire, 67s. 6d.; with Scottish brands at from 79s. to 90s., all delivered Manchester or equal.

THE MIDLANDS.—At Birmingham buyers of foundry pig were few and far between, demand, except for light castings, being on a moderate scale all round. Current quotations rule as follow:—Northants, No. 3, 55s. 6d. to 56s. 6d.; Derbyshire, 60s.; and North Staffordshire, also 60s., all f.o.t. furnace.

SCOTLAND.—In this area the light castings industry continues very quiet, while prices are unaltered. Markets generally are rather depressed, and only a limited tonnage of Cleveland iron has been imported during the current month.

Finished Iron.

Markets for most classes of finished material present few changes, either in condition or prices. The makers of Staffordshire marked bars are still fairly well engaged, and consider it unnecessary to alter the current figure of £12 at works. It cannot, however, be said that there is any improvement in the demand for crown or for nut and bolt iron. With regard to the latter, little support is forthcoming from consumers, who are not very busy at the moment. In certain cases it is reported that crown iron is in a little better demand, but none of the works is able to keep its plant going regularly owing to the slackness of business. This grade of iron is offered at between £9 and £9 10s., and there still exists much competition between Staffordshire makers and those in Derbyshire and Lancashire.

Steel.

In the Sheffield markets orders for railway material and equipment are much below the usual average for this period of the year, but there is still a steady business in basic billets at prices which tend to stiffen for soft qualities. The disappointing feature is the poor demand for Siemens acid billets, which, despite the recent sharp cut in the price, continue to be a very poor market. There are satisfactory dealings in wire rods. Quotations:—Billets: Siemens acid, £9; basic, soft, £6 10s. to £6 12s. 6d.; semi-hard, £7; medium, £7 2s. 6d.; hard, £7 12s. 6d.; wire rods, soft basic, £7 10s.; medium hard, £9; hard, £11 10s. to £11 15s.; acid, £12 10s., all per ton, delivered. In the tinplate market current quotations range as follow:—Coke quality, 18s. to 18s. 3d. basis, with 3d. extra for odd sizes, net cash, f.o.b. Welsh ports.

Scrap.

Reports from the chief markets for foundry scrap material indicate a rather better demand for cast-iron scrap, and at Middlesbrough this week the quotations current ruled at 65s. per ton for machinery in cupola sizes and 50s. for ordinary qualities. Similar descriptions in the Midlands are offered at 65s. and 55s. per ton respectively, delivered works. In Scotland machinery cast-iron scrap is difficult to dispose of even at 65s., and heavy ordinary quality is at 60s. to 61s. Steelworks cast iron is still quoted at around 60s., and light cast-iron scrap at 57s. 6d. to 58s. Cast-iron railway chairs are at 64s. to 65s. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—Fluctuations in values of warrant copper during the current week have again been within unimportant limits, and, so far, the outlook remains confident in a steady and consistent consumptive demand at home and abroad. Business in the United States has been, however, much quieter, and the present situation seems to denote that early deliveries may be anticipated, since it would now appear that there is plenty of metal available.

Closing quotations are:—

Cash.—Thursday, £68 8s. 9d. to £68 10s.; Friday, £68 12s. 6d. to £68 13s. 9d.; Monday, £68 13s. 9d. to £68 15s.; Tuesday, £68 11s. 3d. to £68 12s. 6d.; Wednesday, £68 5s. to £68 7s. 6d.

Three Months.—Thursday, £68 17s. 6d. to £68 18s. 9d.; Friday, £69 1s. 3d. to £69 2s. 6d.; Monday, £69 2s. 6d. to £69 3s. 9d.; Tuesday, £68 18s. 9d. to £69; Wednesday, £68 12s. 6d. to £68 13s. 9d.

Tin.—Excepting the quick fall in prices on Wednesday, movements in standard cash tin have continued the upward tendency previously noted, in contradiction to the normal course of events, considering that there is a definite increase in supply. The rise could only have been brought about by sustained support being given to the market. In its early stages consumers were distrustful of the rise, but the demand experienced recently seems to suggest that conditions reached the point when purchases were necessary.

Official closing prices:—

Cash.—Thursday, £239 5s. to £239 10s.; Friday, £239 17s. 6d. to £240; Monday, £241 10s. to £241 15s.; Tuesday, £239 to £239 5s.; Wednesday, £232 17s. 6d. to £232 15s.

Three Months.—Thursday, £237 10s. to £237 15s.; Friday, £238 5s. to £238 10s.; Monday, £239 10s. to £239 15s.; Tuesday, £237 5s. to £237 10s.; Wednesday, £231 10s. to £231 15s.

Spelter.—A moderate inquiry has been experienced from consumers for all grades of metal, and the consumption of this country seems to be on an extended scale. Expectations of a concrete result from the internal negotiations between producers was the chief cause of the upward movement in values. But up to the present no news of any definite arrangements has been received.

Daily quotations are:—

Ordinary.—Thursday, £26 6s. 3d.; Friday, £26 7s. 6d.; Monday, £26 1s. 3d.; Tuesday, £26 1s. 3d.; Wednesday, £26 1s. 3d.

Lead.—The position in the market for soft foreign pig remains quiet and firm, with a fair demand in this country and from the Continent. The general expectation is that in the near future prices will move only within narrow limits. December is a month when purchases are always low, so that there is little reason to expect a rise in prices, although no serious decline need be feared.

Prices have been:—

Soft Foreign Prompt.—Thursday, £21 16s. 3d.; Friday, £21 16s. 3d.; Monday, £21 15s.; Tuesday, £21 12s. 6d.; Wednesday, £21 8s. 9d.

Pig-Iron Prices in Scotland.

In the Court of Appeal, last week, before Lords Justices Scrutton, Greer and Sankey, Messrs. Palmers Shipbuilding and Iron Company, Limited, of Jarrow-on-Tyne, were the respondents to an appeal which raised a question with regard to the price at which their pig-iron could be sold in Scotland. The appellants, Messrs. William Jacks & Company, of London and Glasgow, brought an action in the King's Bench Division against Palmers Company, in which they claimed damages for alleged wrongful repudiation of an agreement dated July, 1927, respecting the sale in Scotland of the defendant company's pig-iron. Under the agreement the plaintiffs were to deal with the entire output of Jarrow pig-iron available for delivery in Scotland, plaintiffs undertaking to push the sale of it in preference to any other brand, and to base the price on the current prices of Middlesbrough pig-iron f.o.b. makers' wharf or works. During the term of the agreement, it was said, the Middlesbrough producers cut their prices. They published official nominal prices, but plaintiffs found that the current prices were not the prices that were advertised, but something less. Mr. Justice Roche held that the term "current prices" used in the agreement was to be construed as meaning the prices officially published by the Middlesbrough ironmakers and not the cut prices quoted in special circumstances to particular clients. He gave judgment for the defendants with costs.

Mr. H. Murphy, for the appellants, said that two issues arose in the appeal. Messrs. Jacks said first that Palmers Company had refused to let them have the iron at the prices stipulated in the contract, and thereby plaintiffs had been prevented from selling it in such quantities as they could have if they had got it at the contract price; and they had thereby lost their remuneration under the contract. In the second place, plaintiffs said that defendants had treated the contract as at an end at the end of 12 months, whereas in the circumstances it should have continued for 18 months.

Mr. W. N. Raeburn, for the respondents, contended that the Judge was right and that the agreement was for twelve months only. In any case, he contended, the clause with regard to period was so ambiguous that the appellants ought not to be held to establish any case for breach of contract.

Lord Justice Scrutton, in giving judgment, said the main question was what the words "current prices" meant. There appeared to be a regular practice by which the combine gave information of prices on which trade newspapers published a list week by week. The list meant that the combine were saying those were the prices for pig-iron, but it did not follow that each sale of pig-iron was on the terms of the list, because a large quantity might be sold at a lower price, or a lower price might be quoted to attract a buyer. Still, the list price appeared to his Lordship, and Mr. Justice Roche had found it to be, the current price referred to in the agreement. There certainly was no doubt that during part of the currency of the agreement the list prices and the current prices were practically the same.

The difficulty was created when a single agent was appointed—a Glasgow firm—to whom the combine sold their product, and that agent was undoubtedly given rather more right in shading the combined prices than the former individual agents. There was no doubt that in some of the months in which the agreement was in force, iron in Scotland appeared to have been sold at a little less than the list prices, and plaintiffs said: "You did not allow us to base our prices on the average prices at which the sole agent of the combine was selling." It was a difficult question, but Mr. Justice Roche, having heard the evidence, had come to the conclusion that "current prices" in the agreement related to the weekly published list prices. He (Lord Justice Scrutton) did not feel able to interfere with that decision, because he was not satisfied it was wrong. The result was that the first ground on which plaintiffs based their claim failed.

As for the second point, his Lordship considered defendants were not entitled to terminate the agreement at the end of twelve months, and there was a wrongful termination of the agreement. But the plaintiffs' damages were only nominal, and they were only entitled to 1s. The result would be that the Court gave no costs to anyone.

Lords Justices Greer and Sankey concurred.

German Pig-iron in the United States.—According to a German report, Mr. Mellon, the American State Secretary, has signed an Order revoking for the time being, with immediate effect, the anti-dumping Order of January, 1927, against German pig-iron.

THE KEY TO BETTER CASTINGS.

Capponfield

Cold "C.B." Blast

CAPPONFIELD "C.B." is a South Staffordshire Cold Blast Iron, the quality and characteristics of which are known to foundrymen the world over.

This famous Brand is again available, solving the problem of what to use when it comes to a Cold Blast iron — Bradley's Capponfield "C.B." is a *better* quality.

3 Perfect Grades

Capponfield H.B.
(HOT BLAST)

Capponfield W.B.
(WARM BLAST)

Capponfield C.B.
(COLD BLAST)

Bradley's CAPPONFIELD PIG IRON

"Capponfield Quality"

All Capponfield Irons are direct blast-furnace products. Bradley's well-known Refined Irons are made at the Darlaston Works.

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TELEPHONE: DARLASTON 16 (Private Branch Exchange). TELEGRAMS: BRADLEY'S, DARLASTON

WEEKLY PRICE CURRENT.

COPPER.

	£ s. d.
Standard cash	68 5 0
Three months	68 12 6
Electrolytic	74 15 0
Tough	72 10 0
Best selected	73 0 0
Sheets	98 0 0
India	83 0 0
Wire bars	75 2 6
Do. December	75 2 6
Do. January	75 2 6
Ingot bars	75 2 6
H.C. Wire rods	70 5 0
Off. av. cash, November	68 2 3 3/11
Do. 3 mths., November	68 10 11 1/2
Do., Sttlmnt., November	68 2 4 7/11
Do., Electro, November	74 19 7 10/11
Do., B.S., November,	73 1 4 8/11
Aver. spot price, copper, Nov.	68 2 3 3/11
Do. Wire bars, November	75 4 3 9/11
Solid drawn tubes	13½d.
Brazed tubes	13½d.
Wire	10¼d.

BRASS.

Solid drawn tubes	12d.
Brazed tubes	14d.
Rods, drawn	11½d.
Rods, extd. or rlld.	7½d.
Sheets to 10 w.g.	10½d.
Wire	10½d.
Rolled metal	10½d
Yellow metal rods	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8½d.

TIN.

	£ s. d.
Standard cash	232 17 6
Three months	231 10 0
English	232 0 0
Bars	234 5 0
Straits	233 2 6
Australian	233 0 0
Eastern	236 0 0
Banca	233 0 0
Off. av. cash, November	232 19 5 5/11
Do., 3 mths., November	228 0 11 1/2
Do., Sttlmt., November	232 18 11 8/11
Aver. spot, November	232 19 5 5/11

SPELTER.

Ordinary	26 1 3
Remelted	24 5 0
Hard	20 0 0
Electro 99.9	29 10 0
English	26 10 0
India	21 10 0
Zinc dust (Nom.)	35 10 0
Zinc ashes	8 5 0
Off. aver., November	24 16 3 1/4
Aver., spot, November	24 16 0 5/11

LEAD.

Soft foreign ppt.	21 8 9
English	22 15 0
Off. average, November	21 7 0 2/11
Average spot, November	21 4 9 3/11

ZINC SHEETS, &c.

Zinc sheets, English	34 10 0
Do. V.M. ex whf.	33 0 0
Rods	42 0 0
Boiler plates	31 0 0
Battery plates	32 10 0

ANTIMONY.

Special brands, Eng.	57 10 0
Chinese	39 10 0
Crude	33 10 0

QUICKSILVER.

Quicksilver	22 6 6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£7 17 6
45/50%	£12 0 0
75%	£19 0 0
Ferro-vanadium—	
35/50%	14/- lb. Va.
Ferro-molybdenum—	
70/75% c. free	4/3 lb. Mo.
Ferro-titanium—	
23/25% carbonless	1/1 lb.
Ferro-phosphorus, 20/25%	£18 0 0
Ferro-tungsten—	
80/85%, c. fr.	1/4½ lb. to 1/5
Tungsten metal powder—	
98/99%	1/10 lb.
Ferro-chrome—	
2/4% car.	£30 0 0
4/6% car.	£21 12 6
6/8% car.	£20 10 0
8/10% car.	£20 5 0
Ferro-chrome—	
Max. 2% car.	£33 0 0
Max. 1% car.	£37 0 0
Max. 0.70% car.	£42 2 6
70% carbonless	1/- lb.
Nickel—99%, cubes or pellets	£175 0 0
Ferro-cobalt	9/- lb.
Aluminium 98 99%	£98 0 0
Metallic chromium—	
96,98%	2/7 lb.
Ferro-manganese (net)—	
76/80% loose	£13 15 0
76/80% packed	£14 15 0
76/80%, export	£14 10 0
Metallic manganese—	
94/96%, carbonless	1/6 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 3
Finished bars, 18% tungsten	£0 ? 9

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to ⅛ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ¼ in.	3d. lb
Do., under ¼ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.
Bars cut to length, 10% extra.	

Scrap from high-speed tool steel—

Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£ s. d.	£ s. d.
South Wales—		
Hvy. steel	3 7 6	
Bundled steel and shrngs.	3 3 6	to 3 7 6
Mixed iron and steel	3 0 0	to 3 2 6
Heavy cast iron	2 15 0	to 2 17 0
Good machinery for foundries	2 18 0	to 3 0 0
Cleveland—		
Heavy steel	2 18 6	
Steel turnings	2 8 0	
Cast iron borings	2 2 6	
Heavy forge	3 7 6	
Bushelled scrap	2 18 6	
Cast-iron scrap	3 2 6	
Lancashire—		
Cast-iron scrap	2 15 0	to 3 5 0
Hvy. wrought	3 7 6	
Steel turnings	2 5 0	

London—Merchants' buying prices delivered yard.

Copper (clean)	54 0 0
Brass	39 0 0
Lead (less usual draft)	19 0 0
Tea lead	16 0 0
Zinc	16 0 0
New aluminium cuttings	62 0 0
Braziery copper	50 0 0
Gunmetal	50 0 0
Hollow pewter	150 0 0
Shaped black pewter	105 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	68/6
Foundry No. 3	66/-
Foundry No. 4	65/-
Forge No. 4	64/6
Hematite No. 1	71/6
Hematite M/Nos.	71/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	78/-
,, d/d Birm.	83/-
Midlands—	
Staffs. common*	67/6
,, No. 4 forge	56/-
,, No. 3 fdry.	60/-
Shrops. basic	—
,, Cold blast, ord.*	—
,, ,, roll iron*	—
* d/d Birmingham.	
Northants forge	52/6
,, fdry. No. 3	55/6
Derbyshire forge	59/-
,, fdry. No. 3	60/6
,, basic	65/-
Scotland—	
Foundry No. 1	75/-
,, No. 3	70/-
Hem. M/Nos.	74/-
Sheffield (d/d district)—	
Derby forge	61/-
,, fdry. No. 3	63/-
Lincs. forge	63/-
,, fdry. No. 3	64/6
E.C. hematite	81/-
W.C. hematite	82/6
Lincs. (at furnaces)—	
Forge No. 4	58/6
Foundry No. 3	60/-
Basic	59/-
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	68/-
Northants foundry No. 3	—
Dalzell, No. 3(special)	100/- to 102/6
Summerlee, No. 3	87/6 to 90/-
Glengarnock, No. 3	87/6 to 90/-
Gartaherrie, No. 3	87/6 to 90/-
Monkland, No. 3	87/6 to 90/-
Shotts, No. 3	87/6 to 90/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.) nom.		10 5 0
Nut and bolt iron	8 12 6	to 9 0 0
Hoops		11 10 0
Marked bars (Staffs.) f.o.t.		12 0 0
Gas strip		11 10 0
Bolts and nuts, ½ in. × 4 in.		15 5 0
Steel—		
Ship plates	8 7 6	to 8 12 6
Boiler plts.		10 10 0
Chequer plts.		10 12 6
Angles		7 17 6
Tees		8 17 6
Joists		7 17 6
Rounds and squares, 3 in. to 5½ in.		8 17 6
Rounds under 3 in. to ½ in. (Untested)		7 15 0 and upwards
Flats, over 5 in. wide and up		8 7 6
Flats, 5 in. to 1½ in.		7 17 6
Rails, heavy		8 10 0
Fishplates		12 10 0
Hoops (Staffs.)		10 10 0
Black sheets, 24g.	10 0 0	to 10 10 0
Galv.cor.shts. 24g.	13 7 6	to 13 12 6
Galv. fencing wire 8g. plain		12 10 0
Billets, soft	6 5 0	to 6 12 6
Billets, hard	7 0 0	to 7 12 6
Sheet bars		6 0 0
Tin bars		6 0 0

PHOSPHOR BRONZE.

	Per lb. basis
Strip	1 2½
Sheet to 10 w.g.	1 3½
Wire	1 4½
Rods	1 3½
Tubes	1 7½
Castings	1 2½

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	21.26
No. 2 foundry, Valley	17.50
No. 2 foundry, Birm.	16.50
Basic	19.76
Bessemer	20.79
Malleable	20.01
Grey forge	18.76
Ferro-mang. 80% d/d	105.00
O.-h. rails, h'y at mill	43.00
Bess billets	33.00
O.-h. billets	33.00
O.-h. sheet bars	33.00
Wire rods	42.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.95
Tank plates	1.90
Beams, etc.	1.90
Skelp, grooved steel	1.90
Skelp, sheared steel	1.90
Steel hoops	2.20
Sheets, black, No. 24	2.85
Sheets, galv., No. 24	3.50
Sheets, blue an'l'd, 9 and 10	2.00
Wire nails	2.55
Plain wire	2.40
Barbed wire, galv.	3.20
Tinplates, 100 lb. box	$5.25

COKE (at ovens).

Welsh foundry	—
,, furnace	—
Durham and North.	
,, foundry	16/-
,, furnace	14/-
Midlands, foundry	—
,, ,, furnace	13/- to 14/6

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes	20×14 box		18/-
,,	28×20	,,	36/-
,,	20×10	,,	26/3
,,	18½×14	,,	18/9
C.W.	20×14	,,	14/9
,,	28×20	,,	33/6
,,	20×10	,,	21/-
,,	18½×14	,,	15/-
Terneplates	28×20		33/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6 0 0 to £7 10 0
Bars, hammered, basis	£17 10 0 to £18 10 0
Bars & nailrods, rolled, basis	£15 15 0 to £16 15 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£32 0 0 to £33 0 0
Faggot steel	£20 0 0 to £24 0 0
Bars & rods, dead soft, steel	£10 0 0 to £14 0 0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	Fittings.
Gas	67½%	50%
Water	63½%	45%
Steam	60%	40%

W.I. 10% extra.

DAILY FLUCTUATIONS.

	Standard Copper (cash). £ s. d.	
Nov. 29 ..	68 8 9 inc.	5/-
„ 30 ..	68 12 6 „	3/9
Dec. 3 ..	68 13 9 „	1/3
„ 4 ..	68 11 3 dec.	2/6
„ 5 ..	68 5 0 „	6/3

Electrolytic Copper.

	£ s. d.	
Nov. 29 ..	74 15 0	No change
„ 30 ..	74 15 0	„ „
Dec. 3 ..	74 15 0	„ „
„ 4 ..	74 15 0	„ „
„ 5 ..	74 15 0	„ „

Standard Tin (cash).

	£ s. d.	
Nov. 29 ..	239 5 0 dec.	15/-
„ 30 ..	239 17 6 inc.	12/6
Dec. 3 ..	241 10 0 „	32/6
„ 4 ..	239 0 0 dec.	50/-
„ 5 ..	232 17 6 „	122/6

Tin (English ingots).

	£ s. d.	
Nov. 29 ..	238 12 6 dec.	7/6
„ 30 ..	239 2 6 inc.	10/-
Dec. 3 ..	240 7 6 „	25/-
„ 4 ..	238 5 0 dec.	42/6
„ 5 ..	232 0 0 „	125/-

Zinc Sheets (English).

	£ s. d.	
Nov. 29 ..	33 10 0	No change
„ 30 ..	33 10 0 „	„
Dec. 3 ..	34 10 0 inc.	20/-
„ 4 ..	34 10 0	No change
„ 5 ..	34 10 0 „	„

Spelter (ordinary).

	£ s. d.	
Nov. 29 ..	26 6 3 inc.	16/3
„ 30 ..	26 7 6 „	1/3
Dec. 3 ..	26 1 3 dec.	6/3
„ 4 ..	26 1 3	No change
„ 5 ..	26 1 3 „	„

Lead (English).

	£ s. d.	
Nov. 29 ..	23 0 0 inc.	10/-
„ 30 ..	23 0 0	No change
Dec. 3 ..	23 0 0 „	„
„ 4 ..	23 0 0 „	„
„ 5 ..	22 15 0 dec.	5/-

AVERAGE MONTHLY PRICES OF STEEL SHIP PLATES (NORTH OF ENGLAND).

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1896.....	5 0 0	5 0 0	5 2 6	5 2 6	5 2 6	5 0 0	5 0 0	5 0 0	5 0 0	5 2 6	5 10 0	5 10 0	5 2 6
1897.....	5 10 0	5 10 0	5 10 0	5 7 6	5 2 6	5 2 6	5 0 0	5 0 0	5 0 0	5 7 6	5 10 0	5 10 0	5 5 5
1898.....	5 10 0	5 8 9	5 8 9	5 10 0	5 16 3	5 18 9	5 17 6	6 0 0	6 2 6	6 5 0	6 10 0	6 15 0	5 18 6½
1899.....	6 15 0	7 0 0	7 2 6	7 2 6	7 2 6	7 2 6	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	8 0 0	7 6 5½
1900.....	8 0 0	8 0 0	8 2 6	8 5 0	8 7 6	8 7 6	8 7 6	8 0 0	8 0 0	8 0 0	7 10 0	7 0 0	8 0 0
1901.....	6 15 0	6 15 0	6 5 0	6 0 0	6 0 0	6 0 0	6 0 0	6 5 0	6 7 6	6 5 0	6 0 0	6 0 0	6 4 4
1902.....	5 17 6	5 12 6	5 15 0	5 15 0	5 15 0	5 15 0	5 15 0	5 15 0	5 15 0	5 15 0	5 15 0	5 10 0	5 14 7½
1903.....	5 10 0	5 10 0	5 15 0	6 0 0	6 0 0	6 0 0	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 10 0	5 13 11
1904.....	5 7 6	5 10 0	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 11 10
1905.....	5 15 0	5 17 6	5 17 6	5 17 6	5 17 6	5 17 6	5 17 6	6 0 0	6 0 0	6 10 0	7 0 0	7 0 0	6 2 3½
1906.....	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 10 0	7 0 10½
1907.....	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 0 0	7 0 0	7 8 4
1908.....	6 10 0	6 10 0	6 10 0	6 5 0	6 5 0	6 5 0	6 0 0	6 0 0	6 0 0	6 0 0	6 0 0	6 0 0	6 3 9
1909.....	6 0 0	6 0 0	6 0 0	6 0 0	6 0 0	5 15 0	5 15 0	5 15 0	6 0 0	6 0 0	6 0 0	6 0 0	5 13 9
1910.....	6 5 6	6 5 0	6 7 6	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 15 0	6 15 0	6 15 0	6 10 2
1911.....	6 15 0	6 15 0	6 15 0	6 15 0	6 15 0	6 15 0	6 15 0	6 15 0	6 15 0	6 15 0	6 15 0	6 18 4	6 15 3½
1912.....	7 3 9	7 5 0	7 5 0	7 12 6	7 15 0	7 15 0	7 15 0	8 0 0	8 0 0	8 0 0	8 2 0	8 5 0	7 14 10
1913.....	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	7 19 0	7 15 0	7 3 0	6 15 0	6 10 0	7 16 5½
1914.....	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 0 0	6 0 0	7 0 0	7 5 0	7 5 0	7 6 3	7 10 0	6 14 8½
1915.....	8 0 0	8 10 0	9 0 0	9 10 0	9 10 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 5 0	11 0 0	9 12 11
1916.....	11 7 6	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 9 2
1917.....	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0
1918.....	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0
1919.....	11 10 0	14 0 0	14 0 0	14 0 0	17 0 0	17 7 6	17 15 0	18 5 0	18 5 0	18 5 0	19 12 6	21 5 0	16 15 5
1920.....	22 10 0	23 10 0	23 10 0	23 10 0	23 10 0	23 10 0	23 10 0	23 10 0	24 0 0	24 10 0	24 5 0	24 5 0	23 13 4
1921.....	23 5 0	22 10 0	20 4 0	19 0 0	19 0 0	17 0 0	15 0 0	14 15 0	13 12 0	12 5 0	10 10 0	10 10 0	16 9 3
1922.....	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 4 0	10 0 0	9 7 6	9 4 0	9 5 0	9 5 0	9 5 0	9 18 4½
1923.....	9 7 6	9 15 0	10 5 0	10 10 0	10 10 0	10 10 0	9 18 9	9 17 6	9 17 6	9 17 6	9 18 6	10 6 10½	10 1 2½
1924.....	10 1 6	9 18 1½	9 17 6	9 17 6	9 17 6	9 19 4½	10 5 0	10 5 0	10 5 0	9 19 0	9 15 0	9 15 0	9 19 7½
1925.....	9 14 0	9 10 0	9 10 0	9 1 3	9 0 0	9 0 0	8 17 0	8 13 1½	8 7 6	8 5 6	7 16 3	7 14 3	8 15 8½
1926.....	7 12 2½	7 12 6	7 12 6	7 14 4½	7 15 0	7 16 10½	8 2 6	8 2 6	8 4 0	8 12 6	8 12 6	8 16 3	8 1 1½
1927.....	8 17 6	8 17 6	8 11 6	8 7 6	8 6 3	8 5 0	8 5 0	8 3 9	8 2 6	8 2 6	8 5 0	8 5 0	8 7 5
1928.....	8 2 6	8 5 0	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	—	—

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

PIG IRON

REGISTERED TRADE MARK

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

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19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

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(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

IRON MOULDER (48) seeks situation as Foreman. Has been Foreman for 14 years in heavy and light, greensand, drysand castings, cupola practice; can take over ingot mould shop.—Apply, Box 912, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

MOULDER, age 24; green sand, engineering and marine, general jobbing; willing to learn; anywhere.—Reply, "H. B.," 5, Vere Street, Cadoxton, Barry, Glam.

WORKS MANAGER REQUIRED, experienced in foundry and machine shop practice, for works producing heavy non-ferrous castings, and employing about 300 men. Must have first-class organising ability, and be efficient engineer.—Apply, stating qualifications, experience, age, salary required, etc., to Box 926, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

TECHNICAL SALESMAN wanted, with good connection in Midlands; must have thorough knowledge of aluminium alloys; University or similar education and workshop experience advantageous; to sell alloys and deal with technical details between manufacturer and user.—Please apply, BCM CINDAL.

TRAVELLER wanted; experienced in requisites; married; work from London.—Box 922, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

AGENCY.

OLD-ESTABLISHED Scottish Foundry requires Representatives, London, South of England, and West of England, who have connection amongst exporters and users of heavy castings, working on a commission basis.—Box 920, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

PATENTS AND TRADE MARKS.

THE proprietor of British Patents Nos. 212,349, dated January 1, 1923, relating to "Improvements in foundry moulding machines," 227,627, dated January 14, 1924, relating to "Foundry moulding machine," and 242,526, dated December 8, 1924, relating to "Machines for filling moulds for founding," is desirous of entering into arrangements by way of a licence or otherwise on reasonable terms for the purpose of exploiting the above patents and ensuring their practical working in Great Britain.—All inquiries to be addressed to B. Singer, Steger Building, Chicago, Illinois.

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11 ACRES WORKS SITE, SHEFFIELD.

145,000 Sq. Ft. of SHOPPING, Compact and Convenient.

SIDING CONNECTIONS

with L.M. & S. and L. & N.E. Rlys.

WELL-BUILT & COMMODIOUS OFFICES

Will Sell whole or in lots to suit customers, or Let on favourable terms. Unique opportunity for Manufacturers.

Apply—

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ALBION WORKS, SHEFFIELD.

SALE BY PRIVATE TREATY.

TRAFFORD PARK, MANCHESTER.

For Sale by Private Treaty at a bargain price.

MODERN FOUNDRY—ERECTED 1921, with Railway Sidings into Works. Excellent Warehouse and Packing Room and fine Suite of Offices. Area of land 7,173 sq. yds., of which 2,850 are covered by a one-storey erection on same level. Easily adaptable for other trades.

To treat: F. S. Airey, Entwistle & Company, 10, Norfolk Street, Manchester.

MACHINERY.

WANTED, new or second-hand Cupola, 3-ft. 6-in. diameter; price and where to be seen.—Address, Box 924, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

12-FT. x 9-ft. Tilghman Sandblast Room, equal to new, complete with 500-cub. ft. enclosed compressor, separator, cyclone, and exhausting fan; cheap.—Box 916, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

SAND MIXERS.—New and second-hand. Ask us to quote.—W. Brealey & Company, Limited, Prospect Works, Hawksley Avenue, Sheffield.

FOR SALE, CHEAP, No. 2 Britannia Jar Ram Moulding Machine, capacity 10 cwts. at 80 lbs. pressure; 15-in. pattern draw; new; never installed. Mumford Plain Jolt Table, 20 in. x 15 in., capacity 350 lbs.; as new.—Box 910, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

600-LB. Morgan Coke-fired Tilting Furnace, complete with electric blowing fan, and as new, re-lined ready for use, lip axis "A" type; cheap.—Box 918, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOR SALE, Duckham's 20-ton Hydrostatic Crane Weigher, by East Ferry Road Engineering Works Company, Limited; good condition.—Box 904, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

Nearly New "UNION" Horizontal Boring and Milling Machine, spindle 3½ in. dia.

H. W. Ward Internal Grinding Machine, 4 in. centres packed up to 6 in.

BROWN & SHARPE No. 3 Plain Milling Machine, with Vertical attachment, overall size of table 58 in. x 12 in., 34 in. x 9 in. x 20 in.

New 8-in. centres Relieving Lathe, on 4-ft. 3-in. bed.

50-ton "DENISON" TRUCK WEIGHBRIDGE, platform 16 ft. 9 in. x 6 ft., 4-ft. 8½-in. gauge rails, no loose weight steelyard.

Two 40-ton "POOLEY" DITTO, platforms 22 ft. x 6 ft., 4-ft. 8½-in. gauge, no loose weight steelyard.

Eight LANCASHIRE BOILERS, each 30 ft. x 8 ft. 6 in., reinsurable at 120 lbs. pressure.

Three LANCASHIRE BOILERS, 30 ft. x 8 ft., reinsure 150 lbs. pressure.

CATALOGUE (10,000 Lots) ON APPLICATION.

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FLUORSPAR.—The ideal Flux for all Foundry and Furnace work; supplied in crude lump, washed gravel or finely ground. Samples and prices from

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MINEOWNER, MATLOCK.

MISCELLANEOUS.—*Continued.*

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CORBEERITE.—The most efficient and cheapest binder on the British market. Supplied in 40-gallon casks at low prices. Quotations, together with list giving various uses for Corbeerite Binder, including the method of using Sea Sand.

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CARBEST POCKET MICROSCOPE, magnifies 25 times, Fountain Pen size, Cellulose finish, price 6s. 6d. each. Write to-day for yours. All Chemists should possess our Carbest List. Sent free on request.

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WAX CORE VENTS.—Yellow and Black, in all sizes, 1/16 to 3/8 in. diam., always in stock. Cwt. lots quoted special low.

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ANALYSIS AND TESTING.—Send your samples of Iron, Steel, non-ferrous Alloys, Coke, Coal, Oils, etc., to:—

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Moderate fee and prompt reports, special rates for contract

PATTERNS OF ALL DESCRIPTIONS. LARGEST WORKS IN THE MIDLANDS. QUOTATIONS BY RETURN.
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HIGHCROSS STREET, LEICESTER.

SEA SAND, wind blown, absolutely clean, unlimited quantity, 2s. 6d. per ton, free on rail, in 8-, 10- or 12-ton wagons; suitable for coremaking or other purposes.—W. Forshaw, Guildford Road, Southport. Tel.: 67064 Southport.

GANISTER, best quality, for Cupolas, also for Steel Works.—Astbury Silica Company, "The Brooms," Park Lane, Congleton

CHARCOAL.—Powdered, granulated, lump, blacking; inquiries invited.—J. Buchanan & Company, Ashfield Road, Altrincham, Cheshire.

'Phone: 287 SLOUGH.

MOULDING MACHINES

ONE 18"×18" Tabor Split pattern ..	£70
Two 40"×30" Tabor Shockless rollover	£160 each
Two Bonvillain machines (24" dia. boxes)	£120
TWO No. 1 Britannia jolters	£35 each
Four No. 0 Britannia jolters	£20 each
One 24"×48" Tabor Shockless rollover	£140
One 18"×36" Tabor Shockless rollover	£110
Twelve Adaptable Moulding Machines	

ALL ABOVE IN PERFECT ORDER.

LARGEST STOCK OF FOUNDRY PLANT IN ENGLAND. PLEASE SEND FOR LISTS

BUY FROM ME AND SAVE MONEY.

ALEX. HAMMOND, *Foundry Machinery Merchant,*
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